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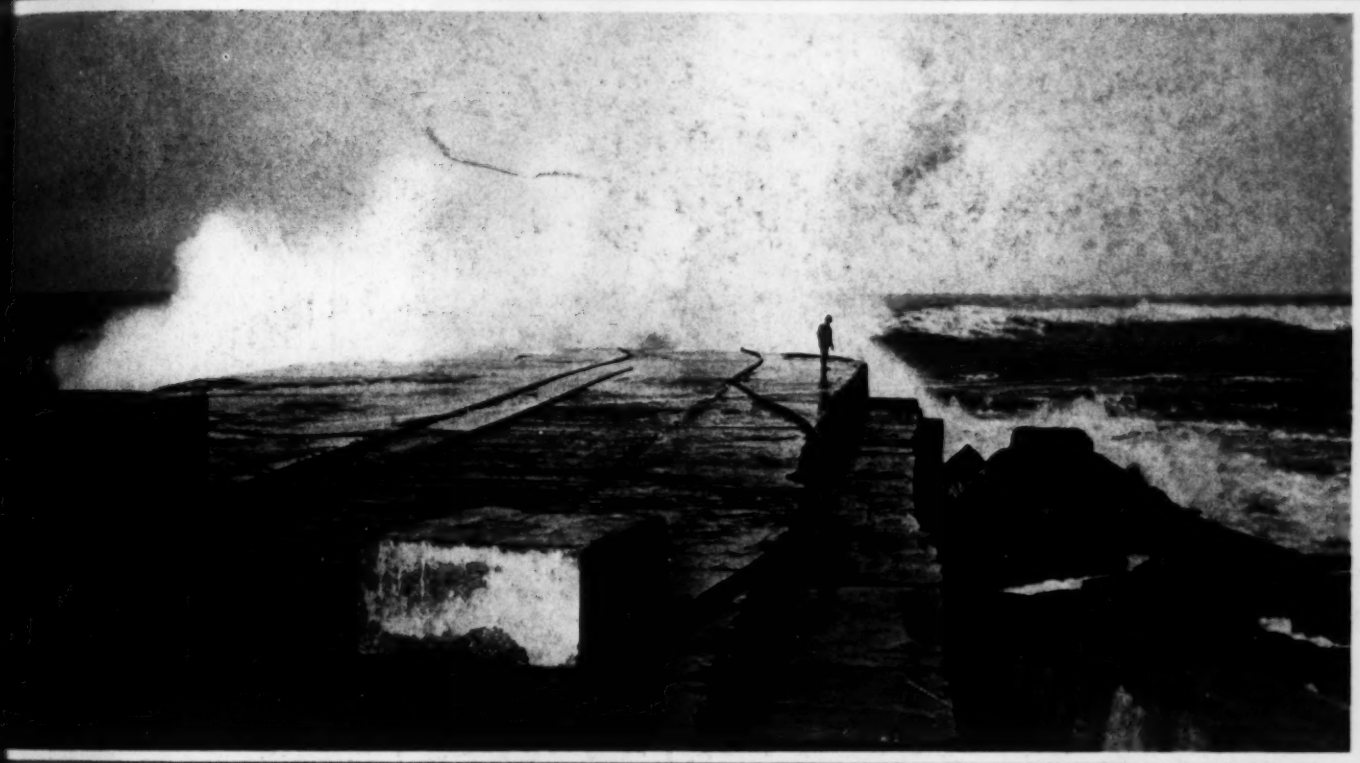

Concrete Blocks Weighing 20 Tons Each Stabilize Rockfill Jetty at Humboldt Harbor, California

IN THIS ISSUE:

Chicago Starts Southwest Sewage Treatment Plant

Stabilizing a Slipping Highway Fill

Rockfill Jetty Stones Held in Place by Large Concrete Blocks

Large Model Used in Bonneville Dam Studies

THE TRIBOROUGH BRIDGE PROJECT IN NEW YORK

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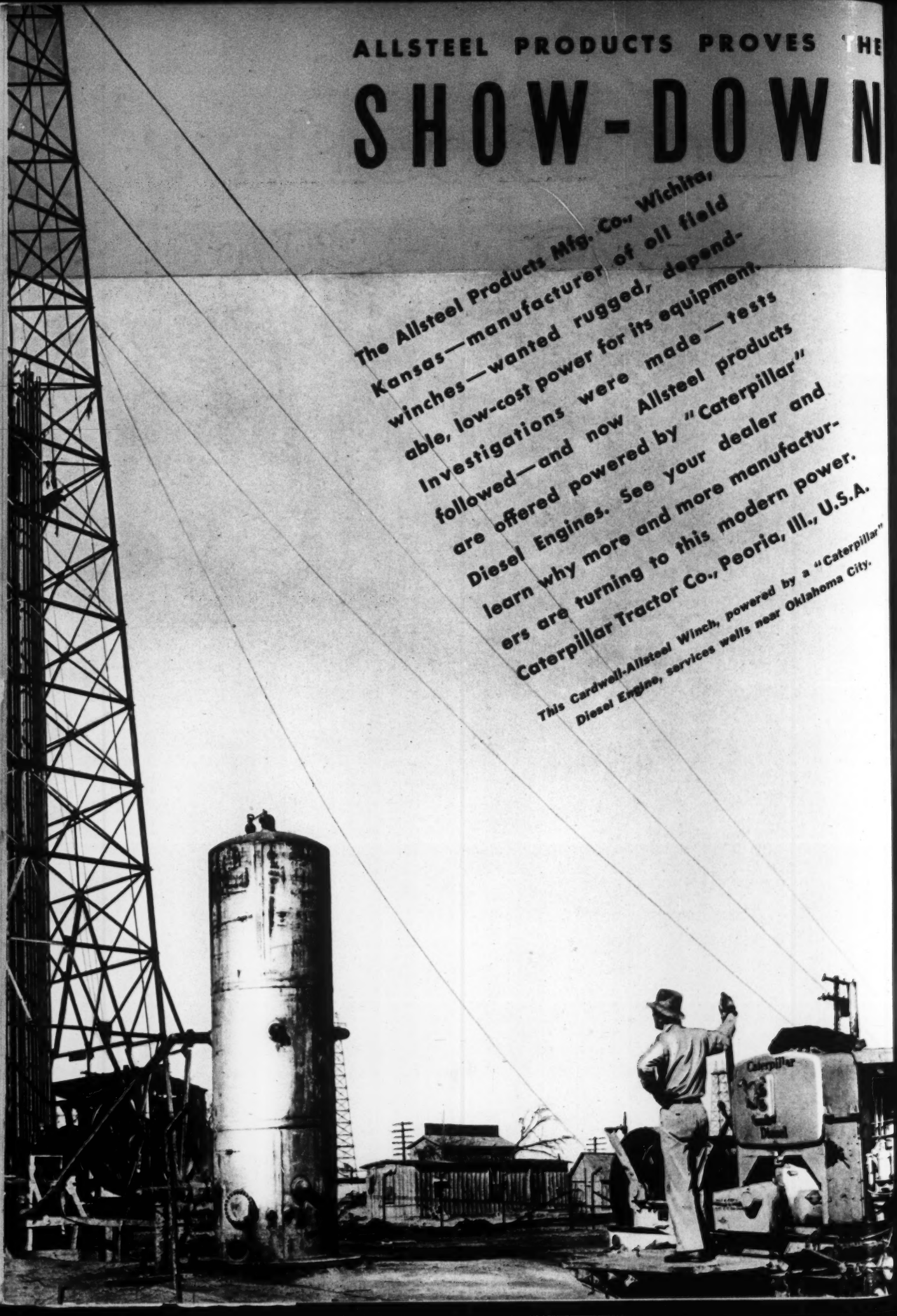

What About TAXES?—*II*

(Continued from issue of August 1)

LAST week this page posed a number of questions which must be answered with reasonable accuracy before we can hope to formulate a policy of sound taxation. We must segregate the so-called costs of government and distinguish between those that provide government *per se* and those that are incurred to render the social and economic services demanded of the community. We must distinguish between current operating and maintenance expenses which should be met from the current income of the community and the capital investments which should draw on the savings of the people. We must recognize and take into account the secondary effects of each form of taxation on the process of creating and distributing wealth and on those human impulses which provide the motive power of productive industry.

That is why this writer is left so cold by the claims that this, that or the other form of taxation will achieve an economic Utopia. No one variety of tax should be considered by itself without respect to other taxation or to the use to be made of the proceeds. No increases in the taxes on large estates, incomes or earnings, for example, can accomplish very much if the proceeds are dumped into a common pool of public funds from which political spendthrifts may dip at their pleasure to meet current expenses. Such expropriation of surplus income could be useful only if it were applied exclusively to meet the capital costs of needed and useful public works, thereby reducing the amount of public borrowing and the resultant burden on the consumer-taxpayer.

NO IMPOSITION of taxation on a selected activity, such as motor transport, in order to raise revenue for general expenses can net us an economic gain while it thus tends to obstruct the development of a new art or industry and thereby to inhibit a wider employment of capital and labor. No method of taxation which, like the present income tax, is confined to a very narrow section of all the people, can keep up indefinitely with the extravagant spending proclivities of those who are exempt from its effects.

Without a doubt we need tax reform. But we do not need tax reform that means more of the hap-hazard, hit-or-miss, log-rolling taxation that we now have. Rather do we need tax reform that will subject every existing and proposed levy to these and kindred tests: what services are to be rendered or public wealth created by this tax? On whom should the costs, in all equity, fall most heavily? How can they be assessed to achieve the most equitable distribution and to insure that those who pay will be influential in keeping them reasonable? What will be the secondary economic effects of such a tax?

THE transition from the simple economy of a century ago, in which the use of capital played so minor a part in public administration, to that of today in which our very existence is so dependent on public works that involve vast investments of capital, has not been adequately reflected in the technique of public finance. Fiscal policies and practice that may have served well the simple governmental needs of another century cannot possibly suffice for the modern community, with capital investments rivalling those of the greatest industrial and utility corporations. Yet for all our patching and adapting we have done but little to recognize this change. Many of our tax difficulties trace back to this source.

The civil engineers, the architects and the rest of the construction industry, all of whom install and administer so many of the great public services incident to modern life, have a vast and special stake in the wise solution of these problems. Their schools, their leaders and their organized groups should find in them, during the years just ahead, ample scope for their best interest and effort.

Willard Chevalier

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ENGINEERING NEWS-RECORD

August 8, 1935

Fairchild Aerial Surveys

FIG. 1—PARALLELING the famous Hell Gate railroad arch and its approaches, the new Triborough Bridge will join Queens, the Bronx and Manhattan to the great advantage of vehicular traffic. In the background beyond Manhattan is the George Washington Bridge over the Hudson.

New York's Triborough Bridge

Joining three boroughs of New York City across famous Hell Gate and adjacent waters, it includes 3½ miles of bridge structure and 14 miles of connecting roads—Suspension span of 1,380 ft. carried by two cables 98 ft. apart

THE TRIBOROUGH BRIDGE in New York City, advancing at a rapid pace toward scheduled completion next summer, ranks with the most notable projects in the country. Its length is nearly 3½ miles, exclusive of some 14 miles of boulevard connections which are a part of the project. Four river crossings, of which one is a 1,380-ft. span suspension bridge, are connected by steel-girder viaducts in spans of 65 to 140 ft. The 98-ft. cable spacing on the suspension bridge is exceeded only by the 106-ft.-width center to center of the pairs of cables on the George Washington Bridge over the Hudson River, and the only comparable bridge that is carried by two cables alone is the Philadelphia-Camden bridge with an 89-ft. width. The $42,000,000 cost of the Triborough Bridge ranks it above the $35,000,000 Golden Gate Bridge and second only to the $75,000,000 San Francisco Bay Bridge among current bridge undertakings. And in economic importance it probably exceeds all but the last-named structure, for by providing an uptown connection between the boroughs of Manhattan, the Bronx and Queens, the Triborough Bridge will relieve materially the congested East River crossings from 57th St. south to the Brooklyn Bridge. As a byproduct, the new bridge will also open up for development as city parks two large East River islands; plans already are drawn for such a park on one of them.

Elements of the project

The Triborough Bridge, with its approaches and connections, is shown in Fig. 2. In accordance with an agreement with the city, the Triborough Bridge Authority, the quasi-public body that is building the project, bears the entire cost of the work on the bridge structures, the approaches and connections, as well as 100 per cent of the land cost for bridges and approaches and 35 per cent of the land cost for the connections.

On the Queens side the approach viaduct rises from the surface at 29th St. on a 3.6 per cent grade to the East River crossing at Hell Gate, which is a suspension bridge, of 1,380-ft. main span and 705-ft. side spans. This is followed by a viaduct structure on Wards Island, over Little Hell Gate and onto Randall's Island to the junction of the Bronx and Manhattan branches. The Bronx approach is a series of truss spans over the Bronx Kills and the N.Y.,N.H.&H.R.R. yards, connecting with a system of concrete ramps to grade in a plaza between 134th and 135th Sts. The Manhattan branch is a plate-girder viaduct as far as the Harlem River, which is crossed by three truss spans, including a 310-ft. vertical lift. West of the Harlem River, a pair of ramps descends to grade in a plaza east of Second Ave. on the line of 125th St., while another ramp curves south to grade at 122d St., where connection is made with a new East River Drive.

Highway connections are being constructed in each of the three boroughs. The Bronx connection, over 6½ miles long, consists of an improvement of Southern Blvd., Whitlock Ave. and Eastern Blvd. as far as Pelham Bay Park. From the bridge plaza at 135th St. and Cypress Ave., Southern Blvd. and Whitlock Avenue (as far as Leggett Ave.) will have a 60-ft. roadway and two 20-ft. sidewalks. Whitlock Ave., from Leggett Ave. to Hunts Point Ave., is being widened to provide two 40-ft. roadways separated by a landscaped mall 60 ft. wide. The roadways are flanked by two 15-ft. sidewalks. From Whitlock Ave. the connection continues along Eastern Blvd. to Mid-

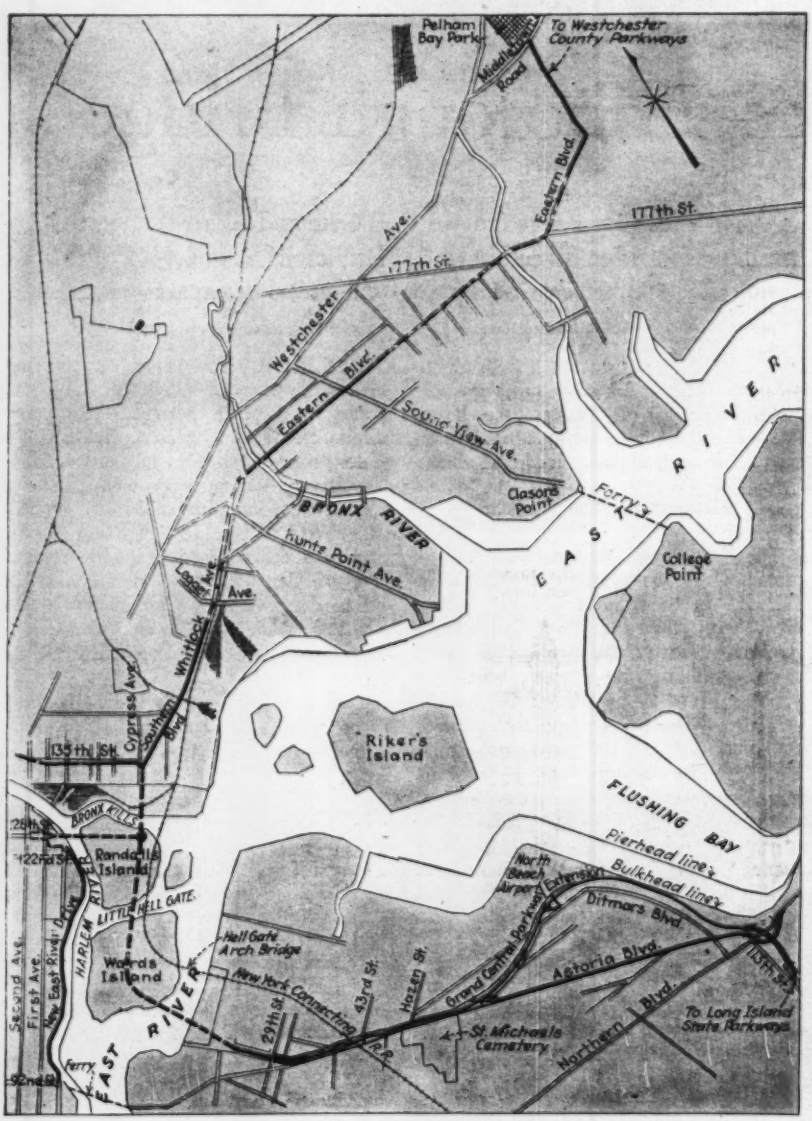
dletown Road as a 60-ft. roadway with two 20-ft. sidewalks.

The Queens connection will also have a total length of about 6¼ miles. From the bridge approach east to St. Michael's Cemetery, the connection will consist of two 42-ft.-wide depressed express roadways separated by a safety strip and flanked by two marginal surface streets, each of which will have a 40-ft. roadway and a 15-ft. sidewalk (*ENR*, March 1, 1934, p. 279). The present Astoria Ave. will form the south marginal roadway. The depressed roadways will be bridged at a number of north and south streets, to provide for the uninterrupted movement of surface traffic. Where the roadway passes under the New York Connecting Railroad at 42d St., it has been necessary to provide new, deeper piers for the railroad viaduct so as to place the footings below the depressed highway.

The depressed roadways are brought to grade at 70th St. opposite St. Michael's Cemetery, where they divide into the Astoria Blvd. branch and the Grand Central Parkway branch. The latter continues as two 32-ft. roadways separated by a safety strip, skirting Flushing Bay and joining with the Grand Central Parkway Extension at Northern Boulevard (*ENR*, March 1, 1934, p. 279). Astoria Blvd. is being widened, regraded and paved for a width of 130 ft. Two 42-ft. roadways will be separated by a 16-ft. mall and flanked by two 15-ft. sidewalks.

The Manhattan connection will parallel the Harlem River waterfront from East 122d St. to 92d St. and York Ave., in a new boulevard similar to Riverside Drive along the Hudson River. It will consist in general of a 125-ft. drive having two 32-ft. roadways, separated by a safety strip, a 15-ft. sidewalk along the west side, and a mall, 40 ft. wide, along the river side. The length of the Manhattan connection, to be known as the East River Drive, will be [illegible] miles. The total length of the connections in the three boroughs will, therefore, be about 14 miles.

FIG. 2—TRIBOROUGH BRIDGE PROJECT in New York includes 3½ miles of bridge structure and 14 miles of approach boulevards. On the north (in the Bronx) it connects with the Westchester County parkways, on the south (in Queens) with the Long Island state parkways, and on the west with the streets of upper Manhattan.



History of the project

The history of the Triborough Bridge project is not so long as that of some other big bridges but it is quite as interesting and varied. One of the first suggestions for a Triborough Bridge was made in 1916 by Edward A. Byrne, then chief engineer of the New York City Department of Plant and Structures; this early project contemplated facilities for both highway and rapid transit. No progress was made until 1925, when the city appropriated $17,000 for surveys, borings and plans, which were made. In 1927, another appropriation of $150,000 was made for further borings and plans. In 1929, a $3,000,000 appropriation was made for final plans for a self-sustaining highway toll bridge, to be financed by city corporate stock. In the fall of the same year, a contract was awarded for the viaduct foundations on Ward's Island and for the two suspension-bridge tower foundations. There followed a further appropriation of $5,000,000 and the letting of contracts for the Ward's Island anchorage (1930) and the Queens anchorage (1931). In 1932, these foundations were completed, but shortly thereafter municipal financing dried up, just as plans were under way for advertising for contracts on the steel towers of the suspension bridge.

For two years the foundations stood stark and bare until, in the spring of 1933, the project was transferred from the Department of Plant and Structures to a Triborough Bridge Authority created by the state legislature as a prerequisite to securing federal financing from the Reconstruction Finance Corp. Before the body could start functioning, however, the Public Works Administration was formed, and application was made for a loan of $35,000,000 and a grant of 30 per cent of the cost of labor and material used in the project, which was approved in the fall of 1933. The loan and grant together total about $42,000,000.

Work was resumed, with a contract let for fabrication and erection of the suspension-bridge towers, when the PWA raised questions as to the possibility that the bridge could not be completed within the funds appropriated. The outcome was the appointment by the mayor of a new personnel for the Authority, and shortly thereafter O. H. Ammann, who had recently so successfully completed the George Washington Bridge, was appointed chief engineer.

A complete check of the design of the project was made which indicated that some $48,500,000 would be required to execute the original plans. A redesign was made, changing materially the char-

acter and appearance of the structures and effecting a saving of about $10,000,000. Later the Manhattan connection from 92d St. was added at a cost of about $6,000,000. The latest estimated total cost of the project is $42,400,000, for which funds are said to be available.

Original design

When considering the present design of the Triborough Bridge structures, particularly the suspension bridge and the viaduct on Ward's Island, it is necessary to understand the elements of the original design, since those elements which had already been constructed or contracted for were important considerations in the redesign. Fig. 4, showing the suspension-bridge towers originally planned, is a key to such understanding. It will be noted that four cables and two decks were contemplated. Four roadways (granite blocks on steel plates), 36 ft. wide between curbs, were each planned for four lanes of traffic, or sixteen lanes in all. Four stiffening trusses, 24 ft. deep with 18-ft.-long panels, were provided. The tower foundations and the anchorages were built for this four-cable layout.

The viaduct sections planned were steel arches on granite-faced piers, with the exception of a series of nine spans just west of the suspension bridge on Ward's Island; these spans were planned to be concrete arches faced with granite. All viaduct foundations on Ward's Island were finished before work was stopped.

The new design

The starting point for the redesign was a consideration of potential traffic capacity. This was placed at 20,000,000 vehicles per year, or 54,800 per day at the end of 25 years. Based on 600 vehicles per lane per hour (the Holland Tunnel has carried as many as 1,000 per lane per hour), eight lanes would accommodate over 57,000 vehicles per 12-hour day. Also, as on all bridges and tunnels, the amount of traffic that the approaches could handle was really the determining factor, and no approaches that could reasonably be provided would care for more than 54,800 vehicles per day. It was concluded that a structure of two decks and sixteen lanes was unwarranted, and since the object was to cut some $10,000,000 off the ultimate cost, it was recommended that the upper deck be eliminated and that eight lanes be provided on a single deck.

The original design, as a matter of fact, had proposed eight lanes for its lower deck, but each of these was only 9 ft. wide, which was considered inadequate. Greater roadway width required elimination of the pairs of columns, stiffening trusses and cables along the center line of the bridge. Detailed study of the problem indicated that such elimination was practicable and would materially aid in reducing the cost of the structure. Although the contract had been let for the original towers and the erector and fabricator were busy with detail plans, very little actual fabrication had been done, so that a minimum of scrapping would be necessary.

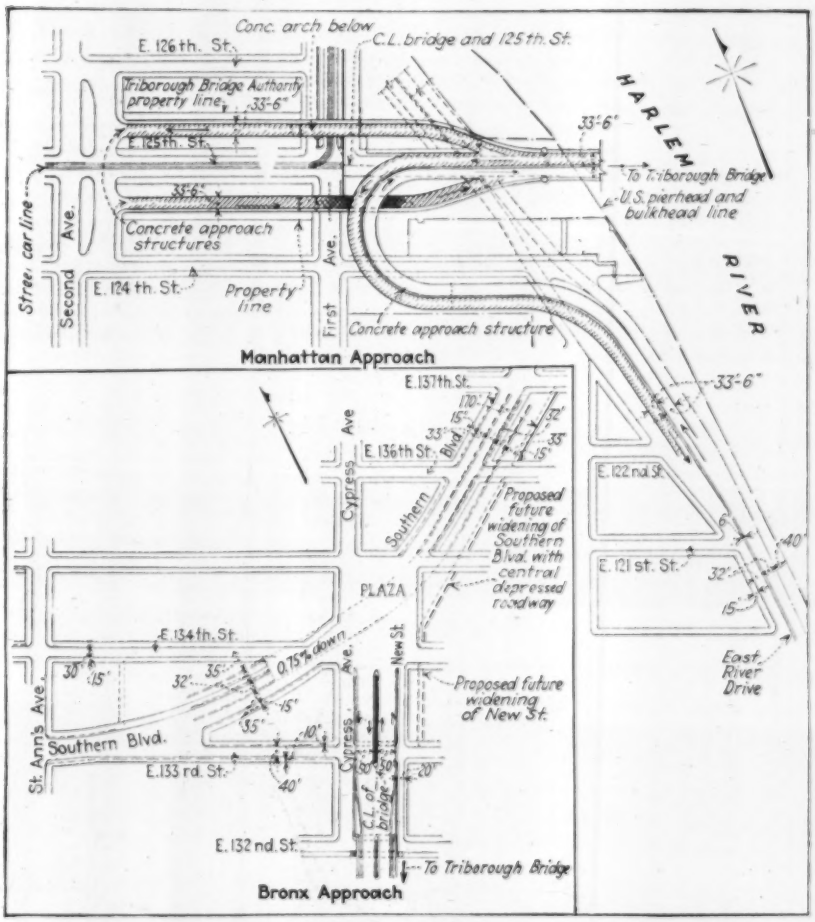
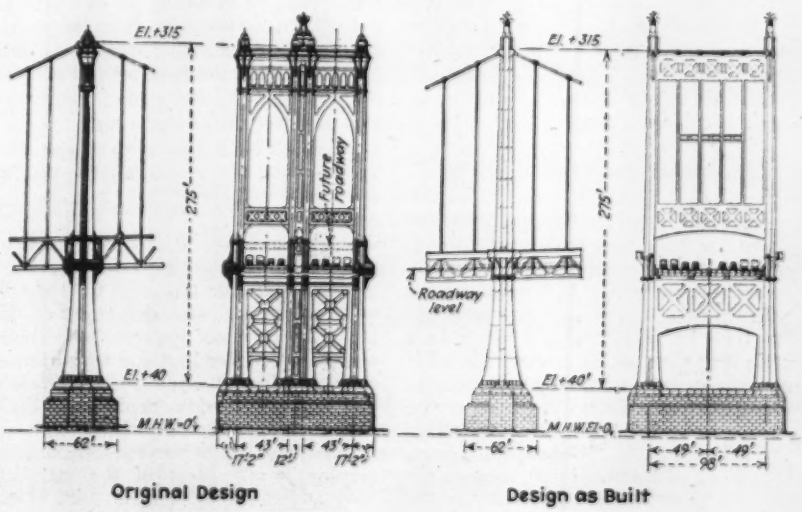


FIG. 3—APPROACHES to the Triborough Bridge from Manhattan and the Bronx are based upon the principles of no crossings at grade and no left turns across approaching vehicle lanes. Dashed lines in Bronx approach indicate future construction.

Further cost savings were sought in the viaduct, and steel truss and girder spans on concrete piers were substituted for the steel and concrete arches. Practically all of the granite facing proposed in the original design (some 1,850,000

FIG. 4—REDESIGN of the suspension-bridge towers to effect necessary economy changed them from four-column to two-column type.



cu.ft.) was eliminated. Of the seventeen footings already built on Ward's Island, the new design was able to utilize thirteen. The other four will be left in place but will be graded over.

As a result of eliminating the upper deck and the two central cables on the suspension bridge, the four-column tower was changed to a two-column tower with simplified bracing and an entirely new appearance. Also the panel lengths of the stiffening trusses were increased from 18 to 28 ft., thus decreasing the number of suspender ropes and fittings; stiffening trusses were decreased from 24 to 20 ft. in depth; floorbeams were increased in depth, but the original design of a girder continuous over four supports was eliminated; the floor was changed from granite blocks on steel plates to a concrete deck on steel cross-beams. These changes reduced the estimated cost of the East River superstructure by about $2,000,000, including $1,000,000 saved by eliminating the center pair of cables.

The other important change in design was an improvement of the intersection at the junction on Randall's Island, to permit all toll-collection facilities to be located at this one point.

The present suspension bridge

Spanning 1,380 ft. across the East River, the suspension bridge, upon which cable-spinning operations were recently completed, has both of its towers on land. Side spans, of loaded backstay type, are 704 ft. 8 in. long from the tower to a cable bent post, which changes the cable inclination from practically horizontal to 45 deg., when it enters the gravity-type anchorage. The two 20⅝-in.-diameter parallel-wire cables, 98 ft. apart c. to c., have a sag of 138 ft. (1:10) between the tops of the towers and the center of the main span. The towers, made up of two cellular columns held apart by three cross-braces located below the roadway, above the roadway and at the top of the towers, are 270 ft. 8 in. high from the concrete pier to the base of the saddle casting. The stiffening trusses with Warren web systems are 20 ft. deep and hinged at the towers. The bridge was designed for a dead load of 20,000 lb. and a live load of 4,000 lb. per lin.-ft. Under such loading the maximum tension in each cable is 22,700,000 lb., and in any suspender rope it is 100,000 lb.

Foundations—Tower piers and anchorages are founded on rock and are located on the shore. The Wards Island anchorage, weighing 115,000 tons, contains 59,000 cu.yd. of concrete. The Queens anchorage, because of a greater depth to rock, required 74,500 cu.yd. of concrete. An interesting feature will be the architectural treatment, the masses being outlined to suggest the direction of the cable pull, the splay of the cable strands and the resistance of the anchorages to overturning. The V-cuts with which this architectural design is attained will also serve as expansion joints, to minimize cracking.

Towers—An elevation and sections of one of the towers are given in Fig. 6. Of fixed-base flexible type, the towers will undergo a maximum deflection at the top of 14 in., under the worst conditions of unbalanced live load and temperature. Column material is silicon steel, while carbon steel is used for the bracing. Each column is of cruciform shape, built up of plates and angles into the conventional cellular form. Most of the material, both angles and plates, is ¾-in. thick. About 5,500 tons of steel is required for the two towers.

The cross-braces between the legs are in the form of X-braced-panel trusses of carbon steel attached to the legs by deep silicon-steel gussets. Chords and web members are box-shaped, with the bottom chords curved except in the top truss. Between the top and intermediate bracing, four vertical architectural members, 93 ft. long and of built-up I-section, are utilized to accentuate the vertical lines of the towers. The top connections of these members are sliding joints, to free them from any bending from tower deflection. Also, at about mid-height, they are braced apart by a light box strut of four angles, to steady them in the wind.

Special details on the towers occur at roadway level and at the stiffening-truss connection 20 ft. above the roadway. At the latter location, box girder brackets with holes for 12-in. pins are provided for the rockers which support the ends of the stiffening trusses. At roadway level in the center of the tower cross-brace, horizontal brackets made up of five 21-in. wide-flange sections set transversely between 1½-in. plates top and bottom furnish a connection for the floor lateral systems of the main and side spans. The actual connection is made by a 10-in. pin; a flat bronze plate around the pin is used to support the laterals on the brackets.

The tops of the towers are to be finished with an architectural lantern 30 ft. high surmounted with aviation lights.

Cables and Stiffening Trusses—The cables are of parallel-wire type, spun in the field. Of a diameter of 20⅝ in. after compaction, each cable contains 37 strands of 248 wires each, every wire galvanized and of 0.196-in. diameter. The cross-sectional area of wire in each cable is 277 sq.in.

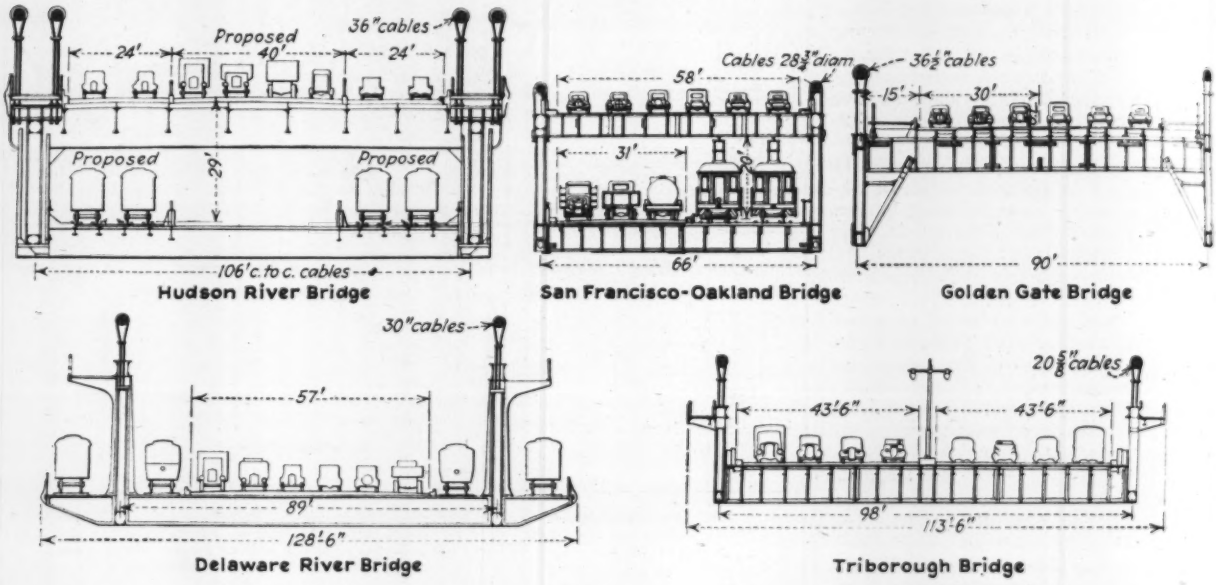


FIG. 5—COMPARISON with roadway widths of other large two-cable suspension bridges places the Triborough Bridge in first place.

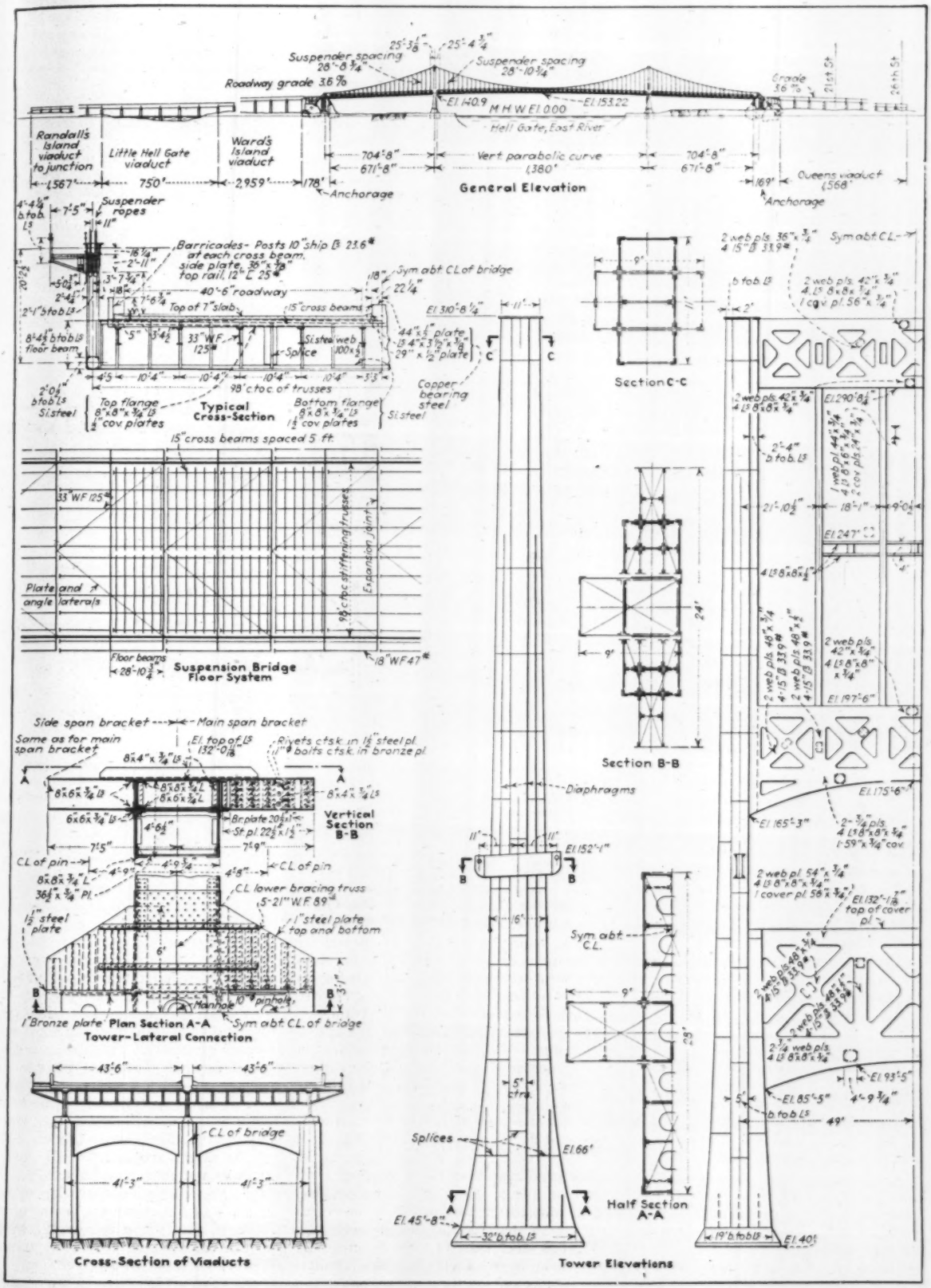


FIG. 6—STRUCTURAL DETAILS OF TRIBOROUGH BRIDGE IN NEW YORK.

The stiffening trusses, as previously noted, comprise an important element of the redesign. By reducing them in depth from 24 to 20 ft., some material was saved in the trusses themselves, and by lengthening the panels from 18 to 28 ft. fewer suspender ropes and floorbeams were required. Offsetting these savings were extra material required in the truss web system, since the panels had to be subdivided to reduce the stresses, and heavier floor stringers because of the longer spans. Nevertheless, the net saving was appreciable. The chords of the stiffening trusses are silicon steel, of plate and angle-box section, with maximum net section of 72 sq.in. in the top chord and 78 sq.in. in the bottom chord. Diagonals are carbon steel. As previously noted, the stiffening trusses are designed for a live load of 4,000 lb. per lin.-ft. of bridge. Wind is assumed at 1,200 lb. per lin.-ft. of bridge, of which 1,095 lb. is floor wind load and the rest comes from the cables.

Floor System—The floor steel comprises one of the most remarkable features of the bridge because of the great width. Floorbeams are plate girders 96 ft. long and 8 ft. 4½ in. deep. Of silicon steel, they are spliced at the third points. There are 46 rivets of ⅞-in. diameter in each end connection, and the end shear is 396,000 lb. The rolled-section stringers, which are placed under the edge of each traffic lane, carry an end shear of 86,000 lb. Stress expansion joints are located at every second panel point.

The roadway that is carried on this floor system consists of two 43½-ft. pavements with a curb island between. The pavement, a 7-in. concrete slab, is carried on steel cross-beams placed on top of the stringers. Inclined monolithic curbs at the sides of each roadway are flanked by a 3-ft. 4½-in. steel barricade.

Viaduct

Some 13,500 ft. of viaduct are included in the project divided about as follows: 1,570 ft. in Queens, 3,000 ft. on Ward's Island, 4,570 ft. on Randall's Island, 3,500 ft. in Manhattan, and 1,000 ft. in the Bronx. The majority of this is of the same design—namely, three lines of deck plate girders on concrete piers in spans from 60 to 140 ft. providing two four-lane roadways as on the suspension bridge. Framing between the longitudinal girders consists of floorbeams spaced 20 to 25 ft., into which are framed the I-beam stringers that support steel cross-beams under the 8½-in. concrete roadway slab. The piers are of three-column type joined at the top with reinforced-concrete ties having a curved soffit. Pier shafts are octagonal in cross-section, a design that was adopted for the sake of appearance but which showed some saving in material over a rectangular section. The tallest shaft is 65 ft. Reinforcing consists of 1-in.-diameter vertical roads and a ⅜-in. diameter continuous spiral. In general, separate footings are used, although those put in for the original arches on Ward's Island and used in some instances for the new design are combined.

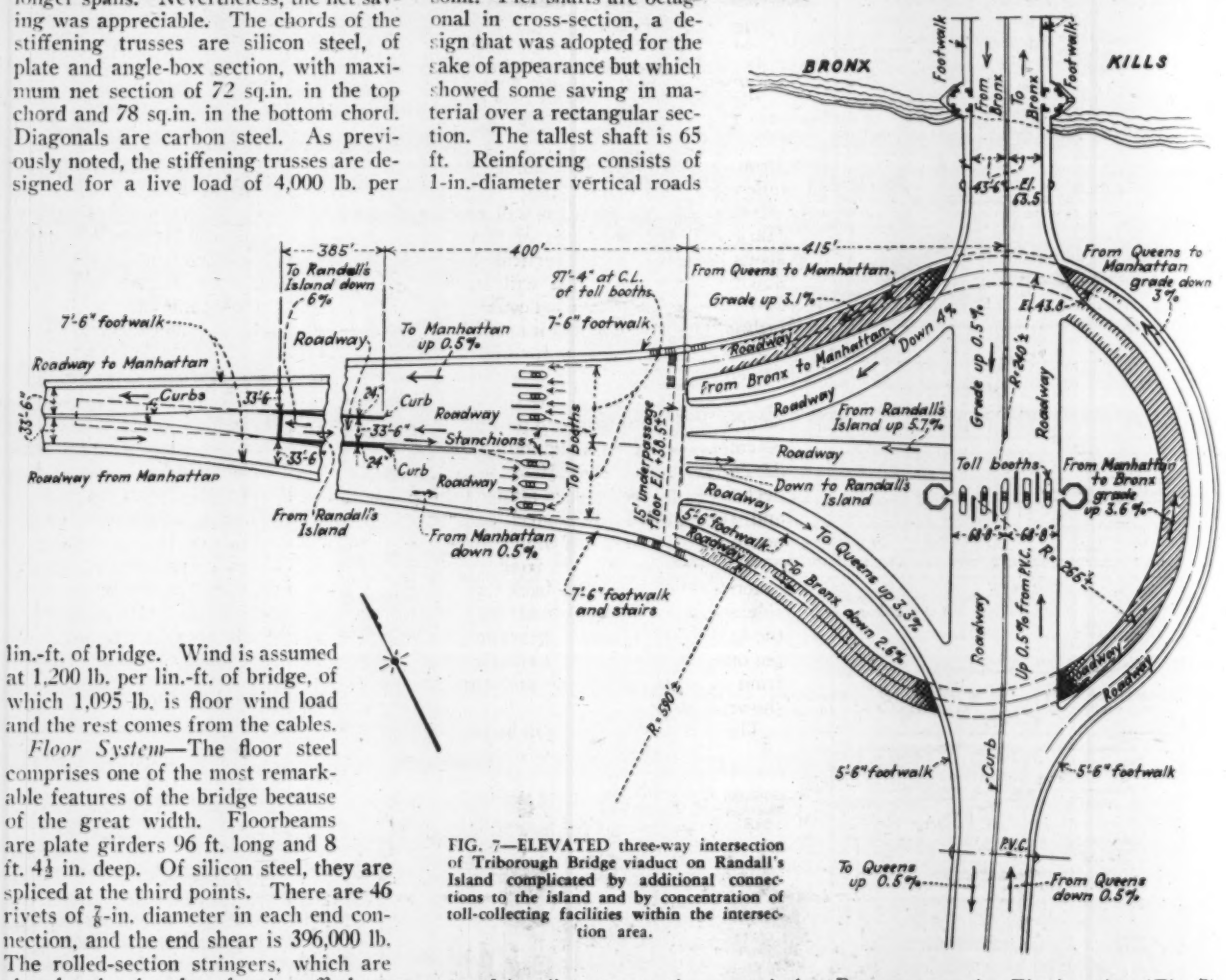


FIG. 7—ELEVATED three-way intersection of Triborough Bridge viaduct on Randall's Island complicated by additional connections to the island and by concentration of toll-collecting facilities within the intersection area.

The 1,500-ft. viaduct approach in Queens, leading to the suspension bridge, is on a 3.6 per cent grade. The only special characteristic is a two-span continuous girder layout near the north end. This provides a 141-ft. clear span for a street crossing, and some economy of material was possible by making it continuous with the adjacent 98-ft. span. The piers are supported on concrete piles with the exception of the six nearest the anchorage, which are on spread footings.

North of the suspension bridge all of the project is viaduct with the exception of two of the river crossings. The Little Hell Gate, which separates Ward's and Randall's islands, is crossed by a series of six 125-ft. girder spans having a clearance of 62 ft. over mean high water.

Randall's Island junction

On Randall's Island the branch to Manhattan intersects the viaduct, which continues on north to connect with the Bronx approach. The junction (Fig. 7) is an elevated concrete structure made up of a continuation of the viaduct from Ward's Island, widened to 137 ft. to provide for toll collection and surrounded by two concentric circular ramps, arranged so that there are no crossings at grade and no left turns, regardless of the origin or destination of the traffic. There are also two ramps located centrally on the Manhattan branch, which provide direct access from all the boroughs to the new Randall's Island city park. It was the incorporation of these ramps, which permit toll entrance but free exit, that made the design of this junction difficult as compared with an ordinary three-way intersection. The ramps have a maximum grade of 6 per cent; elsewhere in the intersection the maximum grade is 4 per cent.

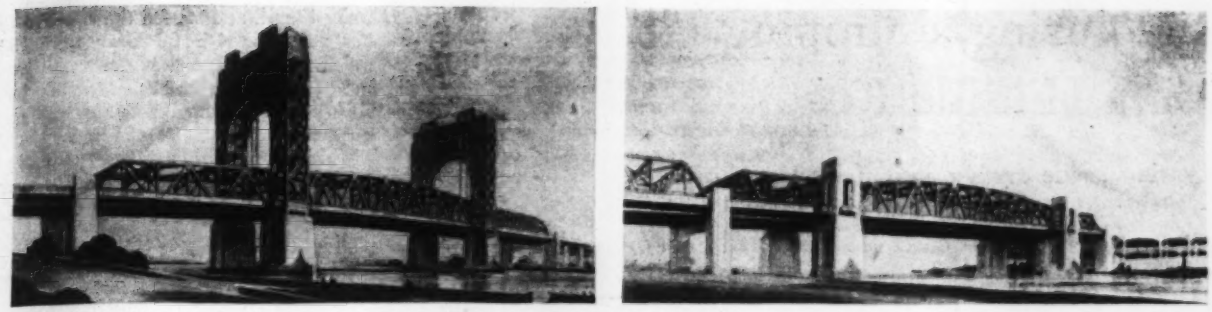


FIG. 8—HARLEM RIVER lift span (left) and Bronx Kills crossing (right), the latter being also designed for conversion into a lift span. Towers of Harlem River Bridge represent a notable departure from previous designs.

The arrangement of the roadways at the junction is such as to provide safe and easy divergence and convergence of traffic. Curvatures have been limited to 240-ft. radius and, where possible, are over 400 ft

Tolls are to be collected at two points. All vehicles passing between Queens and the Bronx will pay toll in the area of the junction where the two roadways of the main viaduct are combined and widened to 137 ft. All other vehicles will pay toll in an area on the Manhattan branch where it has been widened to 195 ft.

Bronx and Manhattan approaches

From the junction, the Bronx approach continues north for a short distance on Randall's Island to a bridge over the Bronx Kills, while the Manhattan viaduct on Randall's Island continues west to a bridge across the Harlem River. These Bronx and Manhattan approaches, as distinct from the connections noted previously, contain some interesting structures.

The Bronx Kills crossing, carrying two roadways of four lanes each and outside footwalks, consists of three steel truss spans—a 350-ft. span over the channel and two shorter approach spans reaching to piers on the shores. The main channel span adjacent to the Bronx shore is located to serve future locks and is designed for conversion into a vertical lift, which would be larger and heavier than any existing lift span, having a net roadway floor area of about 31,000 sq.ft. and a weight of about 2,900 tons.

Beyond the river crossing, over the yards of the N.Y.,N.H.&H.R.R. will be four truss spans (three of 272 ft. and one of 170 ft.) supported on concrete piers founded on rock. The approach structure north of 132d St. (in general, of concrete construction) will reach the ground level at the south side of a plaza area between 134th and 135th Sts. east of Cypress Ave. and will provide direct access to the Bronx connection, extending some 6 miles to Pelham Bay Park.

The Manhattan branch will cross the Harlem River by means of three truss spans, one a 310-ft. vertical lift. In down position the span will furnish a 55-ft. vertical clearance, adequate for the ordinary river traffic, but it may be raised to give 135-ft. clearance for high-masted vessels.

The steel towers for the lift span will be unusual both in size and design. Each is composed of two individual towers, 22x26 ft. in plan and 210 ft. high, connected at the tops by deep arched bracing and surmounted by a steel machinery house. The towers are wholly supported on the piers as distinct from the usual practice of resting the back-leg on the side spans. This expedient adopted for the sake of improved appearance causes the outline of the bridge to depart widely from former lift-span structures, as shown in Fig. 8.

The vertical-lift span will be suspended by 96 wire ropes of 2¼-in. diameter passing over 15-ft.-diameter sheaves at the tops of the towers. Power for the hoisting operations will be supplied by four 200-hp. electric motors housed at the tops of the towers. The span is said to be the largest lift span yet designed when measured in terms of the deck area provided for traffic (20,000 sq.ft.). It is not, however, the heaviest span, every effort having been made to reduce its weight and cost, as for example by the use of asphalt plank pavement laid on steel plate for the floor.

West of the Harlem River Bridge the three-lane offbound roadway separates into two three-lane roadways, one continuing west to a plaza east of Second Ave., the other curving south and back east to a connection with the new East River Drive. Similarly, three-lane roadways are provided for onbound traffic. This Manhattan approach is shown in Fig. 3 From the Harlem River to First Ave. and to a point south of 124th St. it consists of plate-girder viaduct. Elsewhere it is of concrete construction.

FIG. 9—CONSTRUCTION of the viaduct bents involved truck-mixed concrete placed by crane and bucket. Note the octagonal columns and the fluted band along the top of the cap beam just below the forms.

Personnel

For the Triborough Bridge Authority O. H. Ammann is chief engineer, Edw. W. Stearns assistant chief engineer, Allston Dana engineer of design, J. C. Evans engineer of approaches, H. W. Hudson engineer of construction, Aymar Embury II architect. A. I. Perry principal assistant engineer, and E. W. Bowden assistant to the chief engineer. R. F. Wheadon is assistant to the engineer of construction, and J. H. Curtin, H. R. Seely and A. J. Fearing are resident engineers.

Leon S. Moisseiff and Daniel E. Moran act as consulting engineers and Charles P. Berkey as geologist. Ash-Howard-Needles & Tammen prepared the design for and act as consultants on the lift bridges.

For the Federal Emergency Administration of Public Works, Wharton Green is resident project engineer and Charles E. Trout deputy resident project engineer.

Stabilizing a Slipping Fill on a Hillside Road

Setting grade farther into the hill, utilizing a downhill slope wall toed into the rock and installing pipe drains, check Missouri road slide

By Wallace B. Kane
Project Engineer, State Highway Dept., Bronson, Mo.

STABILIZING methods of interest, at least in not departing from familiar procedure to remedy bad slipping conditions, were employed recently on a new highway in the hill country of southern Missouri. At one point the road for about 1,500 ft. skirts the head of a deep ravine on a curve following a winding woods road. The location, indicating possibilities of a slide, led to the decision after the location was made and before the contract was awarded to shift the center line toward the hill.

The formation of the hill is limestone, in horizontal ledges, 2 or 3 in. thick at the surface and 4 or 5 ft. thick at ditch grade. These ledges are separated by horizontal and vertical strata of clay and disintegrated material often no more than an inch thick. This formation was drilled from the surface to grade and was blasted to that depth in one operation. The broken rock was excavated with a power shovel and hauled to the fill. The construction of the fills followed the specifications as closely as possible with respect to horizontal lifts, considering working conditions and the material handled.

Before placing the fill, the surface of the hillside had been "pot-holed," by drilling to a depth of 5 or 6 ft. at intervals of about 10 ft., and blasting, to give the fill a bond to the natural surface. The rough grade was dressed to a plane 1 ft. below plan grade, and the roadbed was filled to grade with borrow material, principally red clay. Grading operations had reached this stage, and it was only necessary to dress the roadway and apply the gravel surfacing to complete the work, when about 6 in. of snow fell and remained on the ground about a week. A warm rain melted it and removed it completely in one night.

Slipping of fill

Upon inspecting the work the next day, it was found that the fill from Sta. 152 to Sta. 153 (Fig. 1) had cracked about 6 ft. from the edge and moved downward vertically 6 to 8 ft. The toe of the fill had slid along the surface of the hill and caused the soil to raise 25 or 30 ft. from the toe, uprooting and overturning large trees. In the vicinity of Sta. 152+50 water had broken through the fill and had washed large rocks, 1 cu.yd. or more in volume, 200 or 300 ft. from

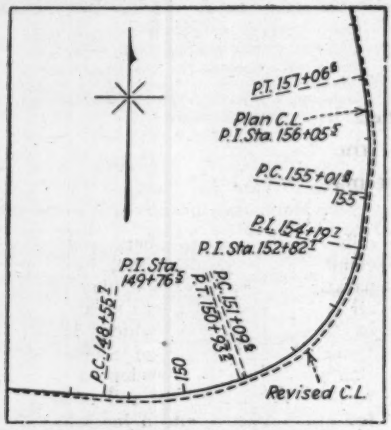


FIG. 1—ALIGNMENT of road at location of slip and subsidence in a side-hill cut-and-fill grade for a Missouri highway.

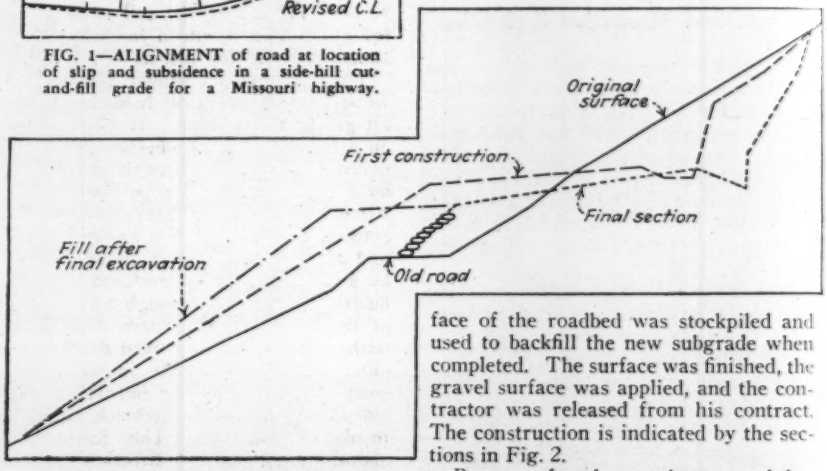


FIG. 2—CROSS-SECTION of side-hill road where slippage occurred, showing change of line and cross-profile to stabilize fill that slipped.

the center line. A stream of water continued to pour out of the débris below the fill, and at the time of its maximum flow as much water as a 24-in. pipe would carry had found its way under and through the fill.

When the rain stopped, explorations were begun to ascertain the source and the course of the water causing the slide. The ditch from Sta. 148 to Sta. 163 was excavated to undisturbed ledge rock, and the backslope was cleaned of all loose material. At Sta. 152+50 a vertical cave in the backslope was uncovered and water was running through it. Evidence was found of considerable flow of water at some time. To the left of the cave and skewed forward across the roadway was a vertical stratum of red clay about 25 ft. wide, which afforded the water a passage under the fill and caused the slippage to start at the toe of the fill between Sta. 152 and Sta. 153. Due to the curved alignment resulting in an arch action in the fill, when the keystone was removed, the embankment slid toward the vacancy and down the surface of the hill. This movement progressed to some extent for over 100 ft. back and ahead of the first slide.

Stabilizing operations

Cross-sections were taken and plotted, the center line was shifted varying amounts, and the grade was revised to place the roadbed in cut or in a fill over the old road existing before construction. No regular curve (Fig. 1) was used, but the shift was made by varying offsets from the staked center line, the maximum being 10 ft. All possible sources of water were noted on the cross-section, new pipe cross-drains were provided in each case and one pipe was removed and relaid. These pipes were laid in rock excavation and were well tamped with clay to intercept all seepage. All excavated rock was wasted on the fill slope along the slide, but the borrow material forming the surface of the roadbed was stockpiled and used to backfill the new subgrade when completed. The surface was finished, the gravel surface was applied, and the contractor was released from his contract. The construction is indicated by the sections in Fig. 2.

Because of settlement, it appeared that the fill would slough badly and probably start a new slide in wet weather. To avoid this, during the dry summer months of 1934, the division maintenance forces excavated at the toe of the fill to uncover a ledge of solid rock which might be used as a foundation for a dry rubble wall. The excavation disclosed that the lighter ledges nearer the surface had been loosened by the "pot-holing," and seepage had lubricated the material between these ledges, causing a plane of slippage parallel to and below the surface of the hillside. A thick solid ledge was uncovered, a trench cut in this, and the dry rubble wall was constructed on a 1-on-1 slope to an elevation 2 or 3 ft. below the shoulder grade. The surface of the roadway was bladed and the fill dressed on a slope of 1½ on 1 from the top of the wall. This resulted in the standard-width roadway.

Since this work was completed, no trouble has been experienced with the

areas so protected, in spite of several very heavy rains and an extremely wet spring season. Portions of the fill adjacent to these areas have developed slides, but these will be stabilized by extending the dry rubble walls during the coming dry summer season. As an additional precaution and to facilitate cleaning, the ditches will be paved with grouted rock across this north hillside where the backslope weathers badly. This will seal the ditch and carry all seepage to the pipe cross-drains without any percolation through the fill.

Adobe Clay Road Surfaces Calcined in Place

Australian adobe soil roads calcined by traveling furnace generally similar to the familiar asphalt-surface heater used in street maintenance

ROAD SURFACES OF CLAYEY SOILS calcined in place are receiving attention in a number of foreign countries that have extensive territories in the pioneer stages of development. Burned-clay aggregate is not an unknown material for road surfacing, but practically always it has been a precalcined material. Calcining the raw clay in place on the road is the unique feature of the foreign practice, and technique and equipment appear to have been most developed in Australia. The following account of Australian practice is by an engineer observer whose statements and judgment are reliable. —EDITOR.

A SLOW-MOVING down-draft furnace traveling about 10 ft. an hour is being utilized for road construction in "black-soil" areas (equivalent to adobe soils) in Australia, in localities where the haul for gravel or crushed rock is excessive.

The inland areas of the two large eastern states of Australia, New South Wales and Queensland, comprise a vast level and undulating terrain where road-making materials are frequently only procurable at high cost for haulage. The annual rainfall of the inland areas of these states is so small that much of the land is semi-arid, and it is only possible to carry on a precarious grazing industry. Under such conditions the normal road traffic is extremely small, and construction costs must be kept to a minimum. The soil is largely composed of a clay of adobe type, which can be traveled over only with the greatest difficulty in wet weather; and as the country is extremely flat, even comparatively small rainfalls may paralyze all road traffic for weeks at a time. It is these conditions which have led Lionel R. H. Irvine, of Sydney, New South Wales, to develop a moving furnace for baking the soil *in situ* and for converting it into a brick-like substance suitable for use as a surfacing.

The machine, as shown below, is a wood-fired down-draft furnace of the air-gas-producer type. It is mounted on a chassis on road wheels and is propelled either direct through gearing or by a winch hauling a rope fixed ahead. Firewood is fed at intervals into the combustion chamber of a gas generator, and air is forced into it above the fire by a fan. The gases produced by combustion are forced through an opening at the base of the furnace and mixed with more air under forced draft; they enter a shallow furnace in which the road surface is the floor and the top and sides are lined with firebrick with an insulating backing. The furnace is about 16 ft. long in a direction parallel to the center line of the roadway, and may be of any width desired.

The machine first used and considered here covered a strip 6 ft. wide, making three trips necessary to give a roadway about 18 ft. wide. As the machine advances over a particular area of soil, the soil is first subjected to the departing gases, and then gradually increases in temperature until the full intensity of the heat of the gases issuing from the generator is felt. Any particular area of soil is enclosed within the furnace for 1½ to 2 hours, the speed of the machine being from 8 to 12 ft. per hour. Work proceeds continuously both day and night, a 6-ft.-wide machine completing about 500 ft. of roadway 18 ft. wide per week.

Prior to heating, the earth is formed to the required roadway cross-section, and the strip to be treated is then scarified to a depth of about 4 in., to render the soil more accessible to the heat. The appearance of the surface of the road immediately after the passage of the heat machine is illustrated below. After treatment the nature of the soil appears to be changed to a total depth of about 6 in. The upper part of the clods created by scarification is frequently in an almost fused condition. The lower part of the clods is of a nature resembling a soft brick. The undisturbed "subgrade" is stabilized by the heating to which it has been subjected. When traversed by a roller, the treated clods are broken down fairly readily. A clay binder is applied to the broken material, the road is rolled again, and it is then ready to be opened to traffic.

The sections of road constructed hitherto have been bound by application of the material composing the mounds of termites (white ants) whcih abound in many parts of Australia. Where "ant-bed" is not available, it is believed that ordinary black-soil will serve sufficiently well.

The experimental machine constructed two sections of roadway, both under the direction of the main roads commission, Brisbane, Queensland, one about ½ mile long near Walloon, Queensland, and the other about 1 mile long near Gatton, Queensland. Two types of clay soil have been treated, and it has been found that the "adobe" type of soil is the easier to deal with, apparently on account of its contained organic matter.

ADOBE ROAD SURFACE being calcined in place (left) by traveling furnace on the front of which is a scarifier that roots up the clay so that calcining produces (right) a coarse aggregate that is rolled with binder material to profile and surface.

Chicago Starts Work on Fourth Large Sewage Plant

Construction of new Southwest disposal unit begun with the award of contracts for intercepting sewers, aeration and final tanks —Ultimate development will rate as largest activated sludge plant in the world—Details of design mark latest advances

By L. C. Whittemore
Engineer of Design, Sanitary District of Chicago, Chicago, Ill.

DESIGNED for an initial average capacity of 400 m.g.d. with provisions for ultimate extension to 1,200 m.g.d., the new Southwest treatment plant of the Chicago Sanitary District will be one of the largest activated-sludge plants in the world. Steam-turbine-driven pumps, blowers and house generators will serve this plant, and it is expected that a sludge-incineration process utilizing waste heat will be combined with the steam-generating unit. The use of air lifts for sludge return in place of pumps is a departure from prior practice and is based on exhaustive studies carried out by the Sanitary District directed toward operating economies.

The Southwest project is located in the town of Stickney on the north bank of the drainage canal and just west of the existing West Side works. This area has a resident population of about 1,200,000 and includes the Stockyards and Packingtown districts with an industrial waste equivalent of approximately 1,000,000 persons.

The intercepting system will be approximately 11 miles long, the sewers ranging in size from 4 ft. wide by 5 ft. high to 17 ft. 3 in. wide by 19 ft. 2 in. high. Between the pumping station serving the present West Side Works and the new pumping station for the Southwest Works, the sewer will be a double barrel section, each barrel being 13 ft. wide by 16 ft. 3 in. high. The extra capacity provided in this section is to permit sewage to be diverted from the West Side area to the new treatment works. Two sections of the intercepting sewer have been recently placed under contract and bids will be received on the remaining sections at short intervals.

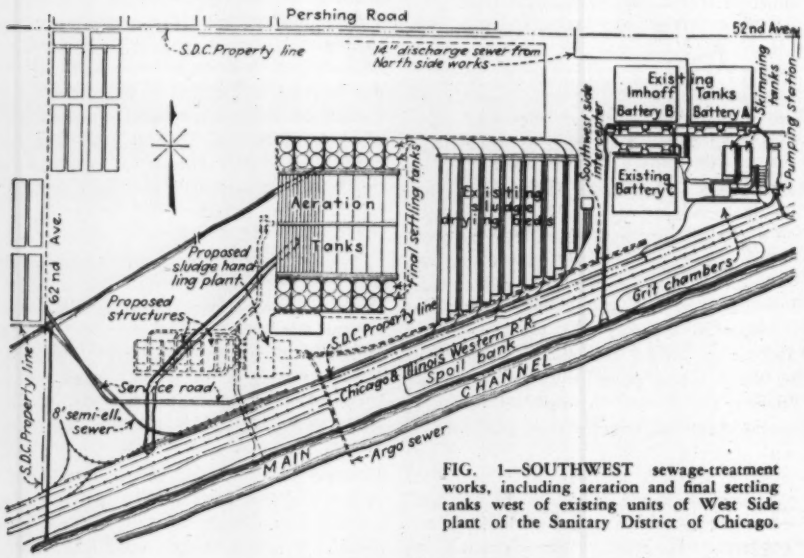


FIG. 1—SOUTHWEST sewage-treatment works, including aeration and final settling tanks west of existing units of West Side plant of the Sanitary District of Chicago.

The treatment works are designed for an initial average sewage capacity of 400 m.g.d. and a maximum of 600 m.g.d., so arranged, however, that they may be extended to an average capacity of 1,200 m.g.d., to provide for complete treatment for the West Side area. The treatment works will consist of a main sewage-pumping station and blower plant, fine rack screens, preliminary settling and skimming tanks, aeration and final settling tanks, and facilities for sludge handling, together with conduits, control structures and a plant outfall to the main channel. It is expected that the sludge (including waste activated sludge from the North Side sewage-treatment works) will be disposed of by mechanical dewatering, drying and incineration. The incineration process will be combined with a steam-generating plant for supplying steam to the turbine-driven sewage pumps, and with blowers and generators for supplying electrical energy for plant auxiliaries. Contracts have already been let for four steam-turbine-driven centrifugal sewage pumps, each with a capacity of 300 c.f.s., against a dynamic head of 54 ft., and for three steam-turbine-driven centrifugal blowers, each with a capacity of 60,000 cu. ft. of free air per minute against a pressure of 7.75 lb. per sq.in.

Bids were received on March 28 for the aeration and final settling tanks and operating galleries and equipment, consisting of sludge-removal mechanisms for final settling tanks, venturi meters and large sluice gates and valves. Other contracts will follow as the plans are developed and the orderly progress of the work requires.

The present installation will consist of two batteries, each comprising eight aeration tanks, sixteen final settling tanks and an operating gallery.

Aeration tanks

Each aeration tank is 434 ft. long, 136 ft. wide, and is divided by non-pressure walls into four channels, making in effect a tank 1,736 ft. long and 34 ft. wide. (The widths given are center to center of walls; lengths are net inside of walls.) The water depth over the diffuser plates is 15 ft. The surface of the plates is 6½ in. above the tank bottom, and a freeboard of 18 in. above the water surface is allowed. The tanks are of the spiral-flow type with the diffusers placed near one wall, with bottom corner fillets and top baffles cast integral with the walls (Fig 3). The design contemplates the use of two rows of 12x12-in. diffusers in each channel. However, provision is made in the contract for changing to one row should experiments now being conducted indicate that this is feasible. The diffuser plates are to be placed in precast concrete containers and arranged so that the feed to 36 plates of the same row is controlled by one valve. Thus, either of the two rows may be shut off or adjusted independently of the other row.

The influent into each tank is through

AERATION PLANT—GENERAL DESIGN DATA

	Initial Installation
Tank Arrangement:	
Number of batteries	2
Aeration tanks per battery	8
Settling tanks per battery	16
Average sewage capacity per battery, m.g.d.	200
Maximum sewage capacity per battery, m.g.d.	300
Aeration Tanks:	
Detention period (average), hours	5
Air use, cu.ft. per gal.	0.5
Sludge return (average), % aver. sewage flow	20
Sludge return (maximum), % max. sewage flow	30
Mixed liquor concentration, aver. p.p.m.	2,000
Mixed liquor concentration, max. p.p.m.	3,200
Final Settling Tanks:	
Settling rate, sewage plus sludge:	
Average, gal. per sq.ft. day	1,200
Maximum, gal. per sq.ft. day	1,950

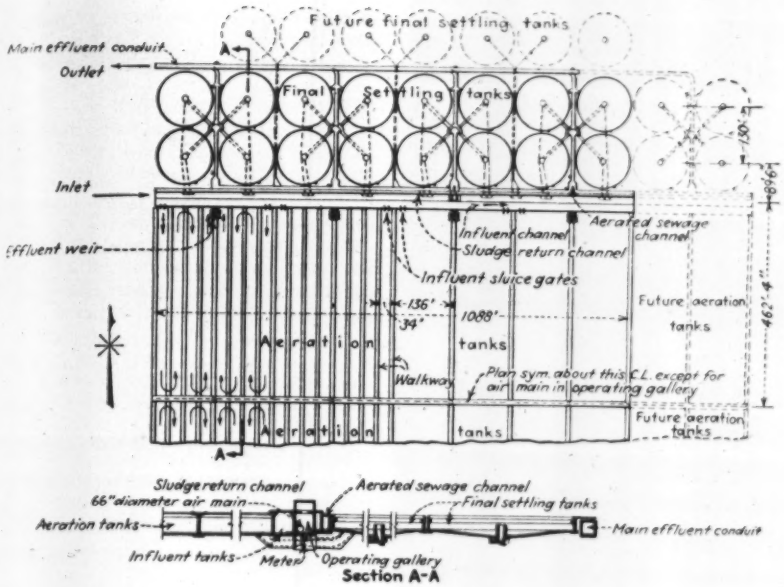


FIG. 2—FOUR-PASS AERATION TANKS, each channel 34 ft. wide, require sewage to travel one-third mile before entering 126-ft. diameter final settling tanks.

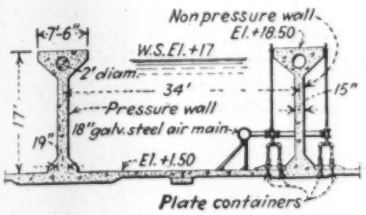


FIG. 3—SECTION through one of four aeration-tank passes, showing pressure and non-pressure walls of cantilever type and piping to diffuser plates.

two 42x42-in. sluice gates, and the effluent is taken off over a long weir and through a 60-in. venturi meter.

The hydraulic design of the tanks and connecting channels and conduits is such that the average and maximum capacity per tank may be increased 25 per cent over the design rate if a shorter detention period is found to be feasible. Space has been left for additional final settling tanks, to accommodate any such increase in capacity.

Final settling tanks

Alternate proposals were asked for on circular tanks with revolving-type mechanisms and for rectangular tanks with conveyor-type mechanisms, the tanks for each battery being arranged in two parallel rows. Contract was awarded on the basis of the circular tanks. These tanks are of the center-feed radial-flow type and are 126 ft. in inside diameter, with a water depth of 11 ft. at the outside walls and a bottom slope of 1 in. per foot toward the center. Groups of four tanks are fed from a central feed well. The feed to each is through a conduit under the tank controlled by a 42x42-in. sluice gate. Aerated sewage is fed to each tank through a baffled diffuser at the center. The effluent is taken off over a continuous peripheral weir. The mechanisms are of the center-drive type with four radial arms carrying scraping blades for moving the settled sludge toward the outlet near the center. The settled sludge is drawn off through cast-iron pipes running underneath the tanks to the operating gallery. The speed of the mechanisms is one revolution in 60 min. Fig. 4 shows the general details of the settling tanks.

Operating galleries

The operating gallery (Fig. 2) for each battery of tanks lies between the aeration and the final settling tanks and is characterized by simplicity of design. Each gallery is 1,093 ft. long and 16 ft. wide inside and is surmounted by a superstructure 9 ft. high.

In the operating galleries are located the air mains, sludge-return drawoffs, meters for air and sewage, control valves for air and sludge return, water lines and electric conduits. Fig. 5 shows a cross-section of the gallery.

The channels for raw-sewage influent to the aeration tanks and sludge return to the final settling tanks are made practically the same depth as the aeration tanks and are parallel to the operating gallery proper. These channels are provided with diffuser plates and are aerated to prevent deposition of solids and to provide thorough mixing.

Sewage is admitted to the aeration-tank influent channel after short mixing with the return activated sludge at the west side of each battery. Compressed air for aeration is also brought in at the west side, and the return sludge channel is carried to the west side of each battery and thence to the point of admission to the incoming sewage.

The sewage to each battery will be measured and regulated by meters and gates, to be located in a control structure west of the batteries. A short period of mixing of return activated sludge and sewage is to be provided before admission to the aeration tanks.

The aeration and final settling tanks

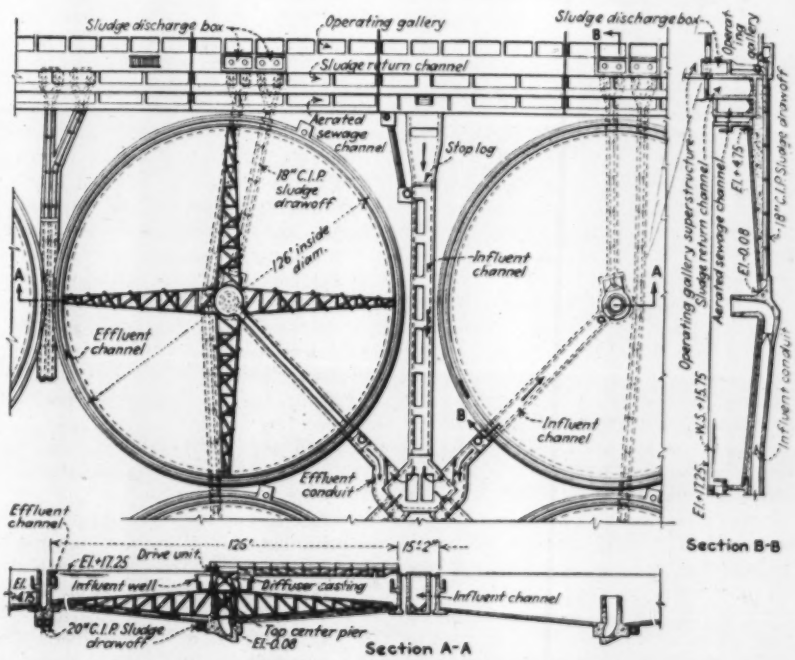


FIG. 4—SETTLING TANK, showing inlets, outlets and sludge drawoffs.

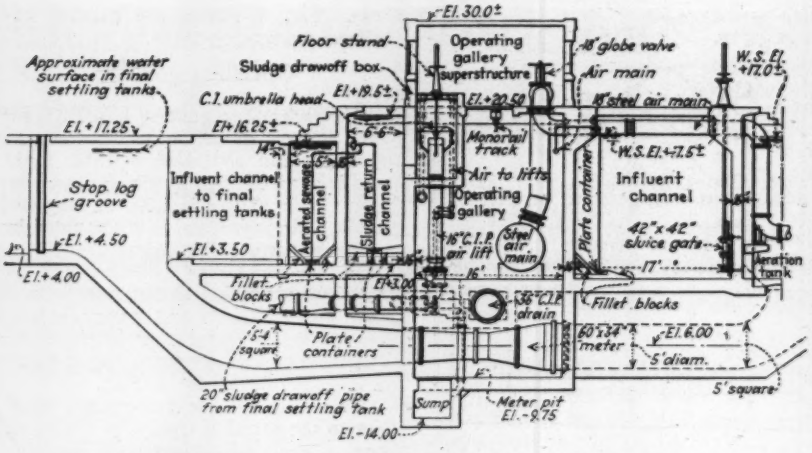


FIG. 5—OPERATING GALLERY AND CONDUITS. Important details are air-operated sludge lift, air supply and venturi meter carrying aerated sewage to final settling tanks.

are so arranged that each pair of aeration tanks feeds a group of four settling tanks (Fig. 2). The settling tanks in turn are so arranged that they hydraulically balance with respect to each other so that uniform flow to each is assured. An equalizing (aerated sewage channel) is, however, provided, to divert flow to adjacent units in case any are shut down.

The air to each battery will be measured by a 66x36-in. venturi meter at the west end of the gallery. The air to each aeration tank will be measured by two 18x7½-in. venturi meters, so that independent control and variation of air to the inlet and outlet halves of each aeration tank are possible. Air for the aerated channels and for the sludge-return air lifts will also be metered.

The effluent from each aeration tank (aerated mixture of sewage and activated sludge) is measured through a 60x34-in. venturi meter. The water surface of the aeration tanks is maintained at an approximately constant elevation by long overflow weirs ahead of the effluent meters.

The sludge draw-off from the final settling tanks is by air lifts into the sludge-return channel at such an elevation that the sludge return will flow by gravity into the influent to the aeration tanks. The use of air lifts for sludge return in place of pumps is a departure from prior practice and is based on extensive study of relative economies and exhaustive tests by the Sanitary District on lifts of the capacity and head required. Two 16-in. air lifts are placed on the one sludge draw-off pipe of each final settling tank. Two air lifts are used in order to obtain efficient operation over a wide range of flows. The wide range of sludge return is necessitated by the fact that, in addition to the normal return required for the aeration process, it is intended to store temporarily excess solids in the aeration system during peak loads, to equalize the load on the sludge-handling facilities and reduce the peak load capacity. As a further aid to efficient operation, the air lifts are equipped with umbrella deflectors, and the discharge elevation is made adjustable by means of telescoping pipe. The air lifts discharge into boxes inside the operating galleries and thence through submerged openings into the main sludge-return channel. The air supply to each air lift is measured by a 4x2-in. venturi meter and is controlled by a globe valve.

The sludge level in each final settling tank will be indicated in the operating gallery by means of a swivel pipe, adjustable for elevation, in each tank connected by 2-in. pipe to a small air lift in the gallery. It is eventually intended to make the draw-off of sludge automatic by using photo-electric cells in connection with the sludge-level indicators, which in turn will actuate motor-operated throttling valves set in the air lines supplying the air lifts. By this device it will be possible to maintain a definite and predetermined sludge level in each settling tank, the rate of draw-off being automatically varied to maintain this condition. Experiments on this feature have been under way at the North Side works for some time.

The 66-in. meters measuring total air to each battery are equipped with complete indicating, recording and integrating instruments for permanent record. All other meters used primarily for adjustment and control are equipped with manometers only.

In order to obtain both easy and economical operation for the large number of 42x42-in. sluice gates, specially designed portable electric operators are provided, instead of having each unit equipped for permanent motor operation.

A large drain that will run back to the pumping station suction channel is provided so that all tanks and channels may be quickly drained.

Air mains in the operating galleries in sizes from 54 to 66 in. are of welded-steel construction. Air headers in the aeration tanks and auxiliary mains in the operating galleries are of spiral welded-steel construction, galvanized. In the sludge-return and aerated-sewage channels the mains are of thin copper alloy of spirally fabricated type, with branches to individual groups of diffuser-plate containers welded in. Galvanized wrought-iron pipe has been used for connections to diffuser-plate containers in sizes larger than 2 in. and stream-line copper in sizes 2 in. and less, and for all sampling lines. Other piping is of cast iron in 6-in. sizes and larger, and of chrome cast iron in 3- and 4-in. sizes.

Structural features

From a structural standpoint the following features are noteworthy:

Due to bad foundation conditions of the site, a part of the final settling tanks will be carried on piles, and parts of other structures will require foundations of lean concrete fill and sand fill.

The aeration tanks of the two batteries are placed back to back, being separated only by a common wall. In order to provide access for maintenance and inspection, a 10-ft. roadway, cantilevering over the tanks on either side, is centered on this common wall (1,060 ft. long). Three out of four walls for each aeration tank are baffle walls only, of somewhat lighter section and much more lightly reinforced than walls between adjacent units. Walls between adjacent units are designed to carry full water pressure with either tank empty or full.

In order to reduce undue shrinkage and cracking in the concrete between the heavy deflector heads and the relatively thin aeration-tank walls, a 24-in. diameter hollow space is provided in the former.

Alternate designs for walls of cantilever and semi-gravity types for the aeration tanks were provided to determine the relative economy of each. Bids were lower for the cantilever walls, and that type is being used.

The use of sewage and sludge channels of the same depth as the aeration tanks has resulted in a relatively simple structural design for the entire plant.

The Southwest sewage-treatment works were designed and are being built under the direction of Philip Harrington, chief engineer; William H. Trinkaus and H. P. Ramey, assistant chief engineers; and Langdon Pearse, sanitary engineer. Others of the technical staff include L. C. Whittemore, engineer of design; Irving P. Kane, engineer of treatment-plant design; F. W. Mohlman, chief chemist; H. I. Steffa, mechanical engineer; J. T. Hawley, electrical engineer; F. L. Finlayson, architect; and Ralph R. Leffler, structural engineer. The construction work is in charge of L. B. Barker, principal construction engineer of sewage works.

Building Wall Underpinned Without Resort to Shoring

By L. M. Zach
Builder, New York, N. Y.

A NOVEL METHOD of underpinning the thirteen upper stories in the northerly half of the Pulitzer Building, Park Row, New York, using steel needle beams and no shoring, was employed in an alteration which substituted a steel column and second-floor girders for heavy masonry walls, thus adding some 30 ft. of show-window space and making available 3,600 sq.ft. of additional store space.

Two 8-in. I-beams, to function as needles, were inserted in each of four 14x14-in. holes drilled through the 60-in. thickness of brick wall on the Brooklyn Bridge side of the building at the second-floor level, and similarly in each of three 14x14-in. holes through a 53-in. thickness of brownstone and brick on the Park Row side. These needles (Fig. 1) were spaced from 30 to 48 in. apart, to hold up the masonry work above them and were located about 1 to 1½ in. above the predetermined elevation of the top of the new steel girders (approximately 16 ft. and 14 ft. 2½ in. above finished first floor), to allow for wedging in between. The needles were then packed with 1:1 portland cement grout, completely filling the remaining void portions of the 14x14-in. holes throughout their lengths. The needles had to be located with particular care at the corner, to avoid subsequent interference with the slipping in of the new steel girders. These needles were permitted to remain packed for over a week, for the grout to acquire sufficient strength for the succeeding operation.

Meanwhile temporary steel beam needles consisting of two 10-in. channels were inserted as shown in Fig. 1, about 5 ft. above the sidewalk and spaced to straddle a prospective new H-column. These needles were supported at their outer ends on wood blocking over an 18-in. subsurface wall adjoining the main 60-in. wall, the needles projecting into the wall well beyond the location of a horizontal chase to be cut for the grillage and of a vertical chase for the column, thus making it possible to cut these chases, and hold up the wall above during the interval. The grillage (Fig. 1) was then slipped in and grouted.

A horizontal chase 26 in. deep x 30 in. high was then cut on the bridge side of the building at the second-floor level for item No. 3 (built-up plate girder). The girder and column (item No. 2) were then erected by means of a truck crane on the street at the curb. To insure intimate over-all contact, lead sheets of ⅛-in. thickness were placed over grillage and billets, under and above the column, respectively, and over the girder for subsequent transverse beams.

Item No. 4 (a 14-in. H-beam) was then erected on completion of the chase along the Park Row side. Double steel wedges, 4 in. wide, were driven between the needles and all the steel girders, also sets of wedges were driven in the brickwork in spaces intermediate between the needles and girders, making the underpinning continuous throughout the length of the girders.

It will be observed that during these operations the needles served as cantilevers, being built-in and embedded on the inner half of the thick walls, supporting the brickwork of the *outer* half-thickness of the walls. Chases for items 5 and 8 were then cut, reversing the

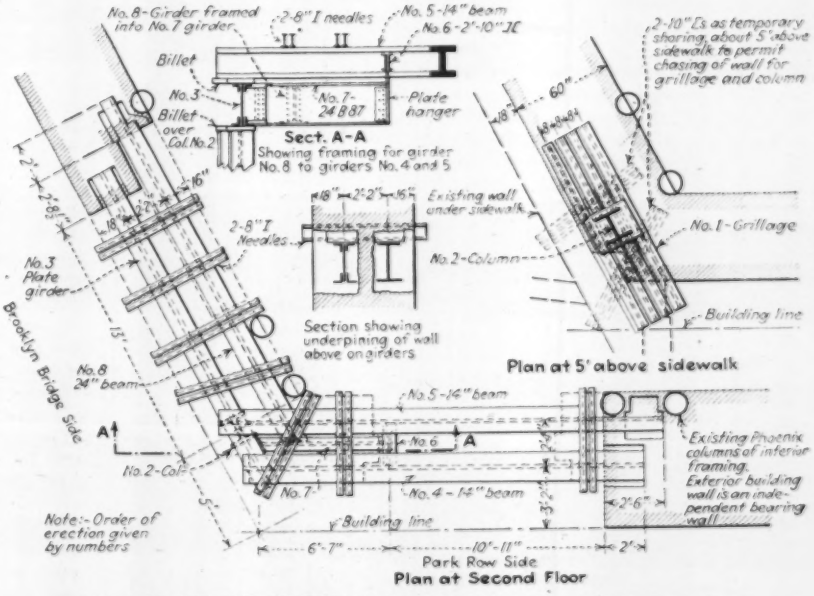


FIG. 1—PLANS AND SECTION of the steelwork for changes in the front corner of the Pulitzer Building, New York.

FIG. 2—ARRANGEMENT of the new wall supports at the building corner at the second-floor level. At the lower left corner is the new column supporting a built-up girder along the side of the building, which in turn carries two H-beams to support the wall on the Park Place face.

cantileverage of the needles, thereby transferring the total weight of the thirteen stories to the outer steel girders and about 10 in. of intervening wall left of the 60-in. wall thickness. The needles then supported the *inner* half-thickness of the wall. Items 5, 6, 7 and 8 were then erected (truck crane being used), and the steel was wedged against the needles and the brickwork.

Framing details

Attention is directed to the method of framing item 8 into item 7, which at one end frames into girder 3 and at the other is hung from items 4 and 5 by means of item 6. The excess projecting ends of the needles were burned off, the rest remaining embedded in the wall.

As the corner angle was about 119 deg., the connections were quite skewed, making riveting extremely difficult. To meet this situation, rivet bolts were used for nearly 100 holes.

The numerous old walls under the sidewalk being of unknown bearing value (some of them being subway walls), and the sub-basement being 28 ft. 6 in. below the sidewalk, the temporary lower shoring for the grillage and new column presented a difficult problem, especially as use of the sidewalk area on the Brooklyn Bridge side was closely limited by the city. The problem finally was solved by locating the bottom grillage only 9 in. below the first floor, thus obtaining just enough height for the grillage to be encased completely under the bulkhead of the corner show-window instead of some 3 ft. below the sidewalk as originally called for, saving a great deal of expense in cutting brickwork and in grillage erection, at the same time making use of the old 18-in. subsurface wall veneered against the main 60-in. side wall as support for the shoring blocks. The foregoing change in plan was made as a result of the more thorough examination of underground conditions (made by the architects and the writer) that was possible after the contract had been let.

The first steel was delivered Nov. 10, and the last piece of steel was set and completely wedged Nov. 21, which is considered a good record in view of the large amount of air-hammer work in chasing and cutting the hard brick wall. This record was made possible in part by the use of alumina cement, the heavy bearing plates being grouted in freezing weather one day and taking load the next day. The same applies to the brick underpinning.

Architect and engineer

The firm of Jardine, Murdock & Wright was the architect, and F. T. Loehninger was consulting engineer on this project. Voepel Sons, Inc., furnished and erected the structural steel and ornamental iron.

Frequency of Intense Rainfall in Iowa Analyzed

STORMS of one to six days' duration were analyzed by the staff of the Miami Conservancy District nearly twenty years ago. F. T. Mavis and D. L. Yarnell, at the Iowa Institute of Hydraulic Research, added to these data intensities from 5 min. to 2 hours, and in a paper presented at the winter meeting of the Iowa Engineering Society showed charts bridging the gap between 2 hours and one day by interpolation. Inasmuch as analyses of intense rainfall data for storms of less than one day's duration are used in estimating the runoff from urban areas and small creeks by the rational method, the value of filling in the hiatus is obvious.

Relatively few recording rain gages exist to supply the basic data, and often data as published include storms in which the duration of the intense rate is less than 1 hour. The paper presented a summary of an analysis of intense rainfall experience at stations in Iowa for periods ranging from 5 min. to six days. It shows an empirical relationship between intense monthly rainfall and intense one-day rainfall of the same average fre-

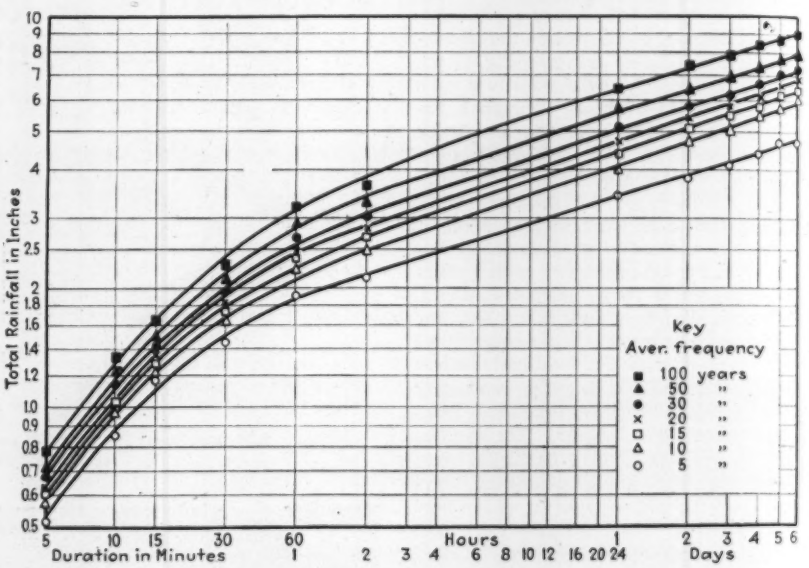


FIG. 1—INTENSE RAINFALL FREQUENCY in Iowa, based on an analysis of the records from seven cities up to Jan. 1, 1934.

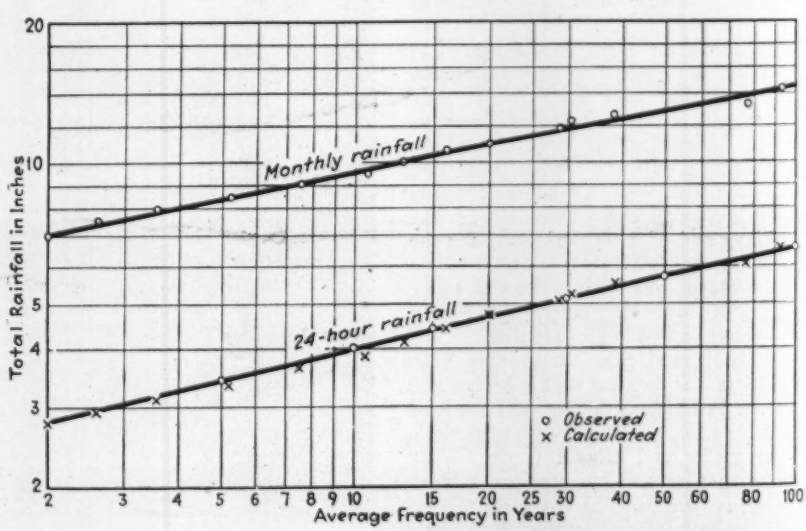


FIG. 2—FREQUENCY of intense monthly and 24-hour rainfall in Iowa, taken from records of stations in seven cities up to Jan. 1, 1934.

quency, and it outlined a method of correlating rainfall and runoff data, which has been suggested by the comparisons of monthly and one-day rainfall of a given frequency.

Average frequencies

In Fig. 1 are shown average frequencies, or the average interval in years between occurrence of a total rainfall equal to or greater than the amount indicated for the particular duration or time of concentration. For the 5-min. to 2-hour period all available data from Dubuque, Davenport, Keokuk, Charles City, Des Moines, Sioux City and Omaha are included. A total of 221 station-years of record is included, or an average of 32 years at each of the seven stations. The average analysis agrees substantially with the analysis of records at the individual stations. The Miami figures for the one- to six-day data were brought down to date from those published, which included only the records prior to Dec. 31, 1914. Variations of intensities between eastern and western Iowa were rarely found to exceed 5 per cent.

Frequencies of intense monthly and 24-hour rainfall in Iowa are compared in Fig. 2. The data come from the same seven cities. Prior studies made by Mr. Mavis indicate a fairly well-defined relation between intense 24-hour rainfall and monthly rainfall of the same frequency.

In charts showing the relation of monthly rainfall and runoff there is always a diverse scattering of points. The authors call attention to the analogy that it should be possible to prepare for runoff and rainfall data, with frequency as a common variable resulting in a definite relation similar in form to that shown in Fig. 2.

If it will be possible to express, for a common frequency, the relationship between runoff and rainfall in terms of watershed characteristics that can be accurately described, it should be possible, the authors hold, to reverse the process and to determine for a watershed of known characteristics the frequency and intensity of maximum rates of flood runoff.

All of which leads to the necessity of additional data pertaining to the flow of large as well as small streams before the studies can be carried forward effectively. The value of continuous records of stream discharge in studies of this kind can hardly be overemphasized, say the authors, and new methods of analysis are likely to follow additional runoff records.

Unique Devices Developed to Aid Dam Foundation Grouting

TVA engineers perfect a "feeler" to determine location depth and thickness of seams beneath dam site, and a "flusher" to wash and clean the openings before grouting

EXPLORING the foundation and washing subsurface seams preliminary to grouting operations have been carried out at Norris Dam now being built on the Clinch River in northeastern Tennessee, with the aid of two novel devices invented by the Tennessee Valley Authority engineers.

The "feeler," shown in Fig. 1, has been used in the examination of several thousand holes drilled in the foundation base. This device, made of pipe fittings, attached to the end of a steel cable and electric conductor firmly taped together, is lowered into each drill hole, in order to locate any seams or faults. The instrument is so fashioned that, when it strikes the bottom of the drill hole, the pressure on the valve at the lower end releases the tension on the two arms, which immediately flare outward, touching the walls of the drill hole. As the instrument is drawn slowly upward, the two arms continue to scrape against the side walls. If a clay seam or recess in the rock is encountered, the remaining tension on the arms is released, and they extend outward as far as they can reach. This movement affects a contact switch and lights the electric lamp in the side of the reel at the surface. The lamp remains lit as long as the arms continue to flare out beyond the normal diameter of the drill hole, and measurement of the cable paid out indicates the depth and thickness of the seam thus discovered.

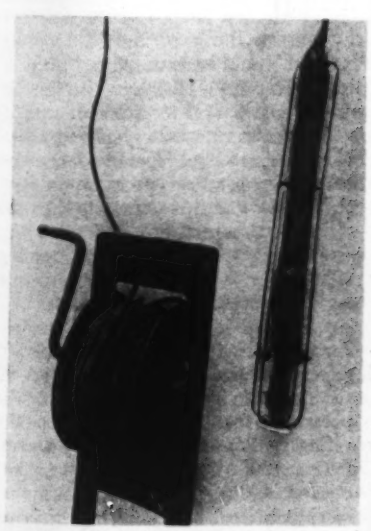


FIG. 1—NOVEL FEELER announces the presence and thickness of seams and fissures under Norris Dam by lighting a small electric lamp.

Shown in Fig. 2 is the "flusher," used in washing clay from the seams located by means of drill holes and the mechanical "feeler." This instrument, essentially a perforated pipe, attached to the proper length of pipe, is lowered to the depth at which the seam is known to exist. Air is forced into the flexible rubber chambers located above and below the perforated water vents in the pipe, and the expansion of these chambers not only holds the flusher firmly at the desired depth in the drill hole but also prevents the flow of water into other channels. After isolating the underground channel in this manner, a mixture of compressed air and water is forced through the flusher into the seam. One or more drill holes in the area under treatment are left open as outlets for the air and water; the others are capped. Moving the machine from hole to hole forces air and water back and forth along the underground seam until the seam is washed clean, indicated by the clarity of the water jet issuing from the outlet holes.

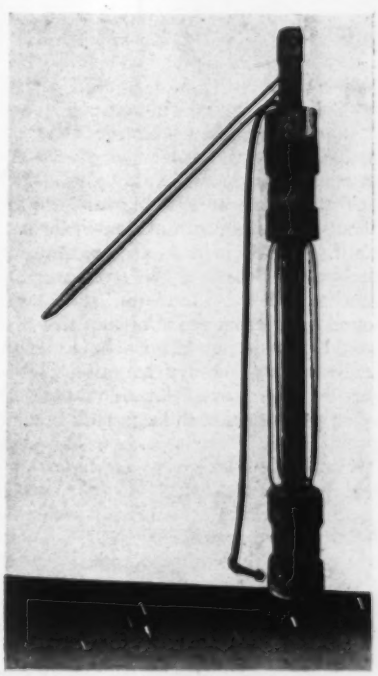


FIG. 2—FLUSHER is held at desired depth by expanding rubber chambers which also serve to isolate the seams and joints for thorough washing.

Concrete Blocks Replace Stone in Jetties Battered by Sea

Precast concrete blocks and a concrete coping adopted as latest resort to stabilize rockfill subjected to seas that quickly dislodge smaller than 20-ton rock in Humboldt Harbor entrance jetties in California

By Geo. F. Whittemore and Lt.-Col. H. A. Finch
Senior Engineer, U. S. Engineer Office *Corps of Engineers, U. S. A.*
San Francisco, Calif.

FIG. 1—ENTRANCE TO HUMBOLDT BAY, showing 2,000-ft. channel between jetties as now maintained; south jetty is in foreground.

A SUCCESSFUL EXPERIMENT in substituting concrete coping and precast blocks for large stone has been under way for the past five years in rehabilitating two large rockfill jetties at the entrance to Humboldt Bay, about 200 miles north of San Francisco, Calif. The decision to use concrete for the exposed parts of the structure was reached when (1) 20-ton stone was found to be about the minimum size that would remain in place above water level under the heavy battering of the seas in this exposed location; and (2) when the cost of such large rock became prohibitive.

Humboldt Bay is about 25 miles long and ½ to 2 miles wide. It is separated from the Pacific Ocean by two narrow barrier beaches or sand spits with an average width of about ½ mile; toward the southern end is the channel (Fig. 1) that separates the spits and connects the bay with the ocean. The channel tended to vary its location, and water depths ranged from 9 to 25 ft. below mean low water, depending upon the season and the condition of the bar. Stabilization of this entrance channel began in 1889, when a single rubble mound was started along its south side.

Early work

Even at the outset it was expected that two jetties eventually would have to be built, but as an experiment the south jetty was started first in the hope that channel conditions would improve. However, as soon as the south jetty had been extended for half of the projected length of 6,000 ft., such heavy erosion occurred on the north sand spit that immediate construction of the north jetty became necessary to establish the desired channel width.

The original jetties were completed in 1899 as rubble mounds. They comprised about 1,150,000 tons of dumped stone, and their total cost was slightly more than $2,000,000. The original length of the north jetty was 4,500 ft. and of the south jetty, 5,100 ft. The original rockfill was founded on brush mattresses 4½ ft. thick and 45 ft. wide, intended to retard settlement.

More important than settlement, however, was the major problem of preventing the rockfill from being battered to pieces by the heavy seas (Fig. 2). It soon developed that constant repairs were required to maintain the jetties. In 1899, after completion of the first project, it was hoped that the battle had been won, but by 1906 the rockfills were badly wrecked, and the channel, which had shown notable improvement for several years, again became unsatisfactory.

Between 1911 and 1927, working intermittently, the structures were completely rebuilt, at a cost of $5,585,000. Prior to 1917 the cost of the stone put into the jetties was about $2.10 per ton in place; in later years this figure increased to about $4.25 per ton, including a concrete deck on each jetty and a concrete monolithic head.

Undoubtedly the original maximum limit of 10 tons for the individual pieces of armor stone was too small. However, that was about the limit of weight that could be handled by machinery available at that time, particularly by machinery working on a "sea-going" trestle. During the reconstruction period the limit was raised to 20 tons, but, even so, a large percentage of the stone placed was in smaller pieces; much of this was subsequently lost.

Between 1927 and 1931 a series of severe storms made extensive rebuilding of the jettyheads necessary. Heavy winter seas, coming nearly head on, often would wipe out an entire season's work in a few stormy weeks. Many of the smaller stones would be washed away almost as fast as they could be put in place.

Even at the higher price paid for stone in later years, about three-quarters of the total tonnage was in sizes too small; these smaller stones were carried away by the first storms. It became evident that anything as light as 10 tons in weight would be battered out of place in a short time. However, in the absence of any market for stone of smaller sizes there was no quarry near by that could produce segregated large-size stone in quantity except at prohibitive cost. It was at this junction that the decision to resort to concrete was reached.

Concrete construction plan

As early as 1915, concrete monolith jettyheads about 50 ft. square and 10 to 12 ft. thick had been built, with the expectation that they would stop the raveling action of the heavy waves. The outer 100 ft. of each jetty was thus protected. The forms for the monolithic blocks had been built up of large stone, chinked with sacks and paper; the block itself rested on the leveled-off surface of the original fill at about the low-water level. By 1925-26 these

FIG. 2—HEAVY SEAS breaking over jetty heads make 20-ton blocks a minimum size for stable armor. Note destruction of track.

monoliths had careened and settled so badly that it was necessary to reconstruct them. Steps then were taken to protect the rubble foundation of the jetty heads by monolithic concrete wing blocks 30 ft. square and about 8 ft. thick, laid on each side of the jetty heads on a rubble foundation built up to about midtide level.

These wing blocks originally were laid out on a horizontal plane, level with the crown. As the rubble foundation of each block was washed out along its outer edge, it was anticipated that the block would settle to an inclined position and eventually come to rest on a slope of 45 deg. or thereabout, where it would serve as a buttress to protect the rubble foundation of the crown blocks and absorb the battering that otherwise would fall upon the main structure.

This expedient worked quite successfully, although in some cases as the wing blocks settled at their outer edges they moved away from the jetty crown so far that the main structure was left without sufficient protection.

By 1931 storms had so badly cut down the rockfill landward of the concrete jetty heads that it was decided to carry the monolithic concrete construction shoreward about 150 ft. and to reconstruct the original jetty heads, whose blocks had settled and tilted badly.

Prior to this time the side slopes of the concrete monolithic blocks had been armored with large stone up to 18 or 20 tons in weight. With the decision to extend the monolithic concrete construction, it also was decided to substitute precast concrete blocks for the large stone previously used as riprap. These blocks were made in wooden forms constructed on the job and lined with 20-gage sheet iron. Cubical shape would have been most suitable for random use, but an approximation to brick proportions was adopted because of its utility for form-wall building. The blocks measured 9½x6½x4½ ft., contained about 10 cy. yd. and weighed 21 tons. These blocks gave good service; the rough handling during placement and the mauling given them by wave action caused much spalling of edges and corners, but on the whole the blocks were highly effective. They contained no reinforcing, and the rule was to allow them to set at least three days before being handled by the crane.

The capacity of the gantry crane used (20 tons on a 50-ft. radius) restricted the size of the precast blocks. Realizing that larger blocks would be more dependable, an experiment was made with four 50-ton blocks. These were constructed in precast concrete "containers" (Fig. 3) consisting of outside walls and a partition; the thickness of the walls was so figured that the weight of each container was about 20 tons. These cellular blocks were then placed at the top of the slope where the larger blocks were desired. When thus placed, the cells were filled with concrete and, after curing, the entire block was tipped over to roll down the slope into position. The experiment was not a success; the 50-ton blocks soon broke up into separate sections or settled below low-water level—at any rate nothing was seen of them after the first winter of their service.

Methods of carrying on the work

The reconstruction, which made extensive use of concrete, was begun in 1930 and was carried out by the following steps:

1. Concrete was mixed in a yard near the jetty and for precast blocks was poured into forms on cars in the yard (Fig. 4). These blocks were stored on the cars or along the jetty. Concrete to be poured on the jetty was mixed in the yard and hauled to the work in 2-cu.yd. skips stacked on flat cars.

FIG. 3—PRECAST CONTAINERS used in casting 50-ton blocks by filling compartments with concrete after containers were placed.

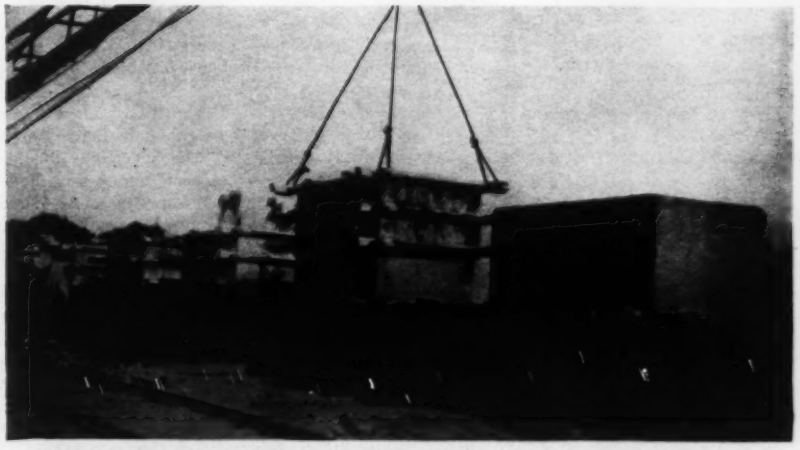


FIG. 4—CASTING BLOCKS in the yard. After curing, they were placed in parallel rows between which the monolithic crown of the jetty was molded.

2. The slopes of the jetty were made of these blocks and of slabs cast in place; the body of the jetty consisted of monoliths cast in place inside parallel walls (Fig. 5) built up with the precast blocks on two sides and an end wall (Fig. 6).

3. The monoliths were formed with bottom elevation slightly above low tide, after excavating and leveling the old and irregular enrockment. Their dimensions ordinarily were 30 ft. square by about 13 feet. deep, each containing about 400 cu.yd.; the usual setting was with crest about 12 ft. above low tide.

4. When a monolith had set at least one day, the front end-wall blocks were removed and set aside to be placed ahead for the next form; the side blocks were left in place.

5. Other concrete form blocks were used to riprap the slopes, which were built up to full cross-section later, by use of either slope slabs or random blocks.

6. The monolithic body of the jetty was built seaward to the jettyhead, and the side slopes then were built to full cross-section, first on the weather side and later on the channel side, working shoreward from the jetty head.

7. Where concrete surfaces were subject to wave wash soon after setting, it was found desirable to use 3 to 4 lb. of calcium chloride per bag of cement to accelerate the setting; this procedure was followed for the top layers of the crown blocks and of the side-slope slabs that were cast in place.

In these reconstruction operations about 34,000 tons of concrete were placed, at a total cost of $294,000, or $8.70 per ton. Deducting items of $1.18 per ton for track repairs, 12c for repairs to water system and buildings, 90½c for repairs to rolling stock, the net cost of the concrete blocks was about $6.50 per ton, made up of the following items:

Concrete	$5.64
Forms	.13
Transportation	.20
Placing	.53
Total	$6.50

Total costs of the work segregated by periods were as follows:

Total cost prior to 1899	$2,000,000
Intermittent reconstruction, 1911-1927	5,585,000
Concrete monoliths started in 1930	294,000
Total to date	$7,879,000

Conclusions

From this rather large-scale experiment in jetty construction the following conclusions may be drawn:

1. Concrete is an excellent and economical substitute for large stone in breakwater or jetty construction where stone is scarce or where large pieces for armor purposes are hard to obtain.

2. For exposed works in stormy localities, large concrete blocks are most economical for the superstructure. In such cases the so-called "filler" stone in rubble-mound enrockments is largely valueless, because it is soon washed away under heavy wave action. For the foundation (10 to 15 ft. below low water, depending upon the exposure) it probably would be more economical to use 10- to 20-ton concrete blocks and a lighter cross-section; this is possible because the underwater angle of repose is much steeper.

3. No reinforcement is required, except in special cases such as comparatively thin slabs and in cellular blocks; in these some reinforcement is needed.

4. The best mix appears to be 1:2:4. As much time for mixing as practicable should be allowed, up to 3 min. for each batch.

5. No accelerator is required, except on the surface of the blocks cast in place and exposed to wave wash.

6. Where mass concrete is used, as in monoliths for the jetty heads, as much as one-third of the mass may be plums or one-man stone, properly distributed throughout the concrete.

7. Large concrete blocks are the most effective and ultimately the most economical material with which to repair an exposed rubble-mounted structure—assuming a reasonable price for cement and a fairly high cost for large stone.

8. A water-cement ratio of 6 to 7 gal. per sack is best.

9. Forms should be watertight.

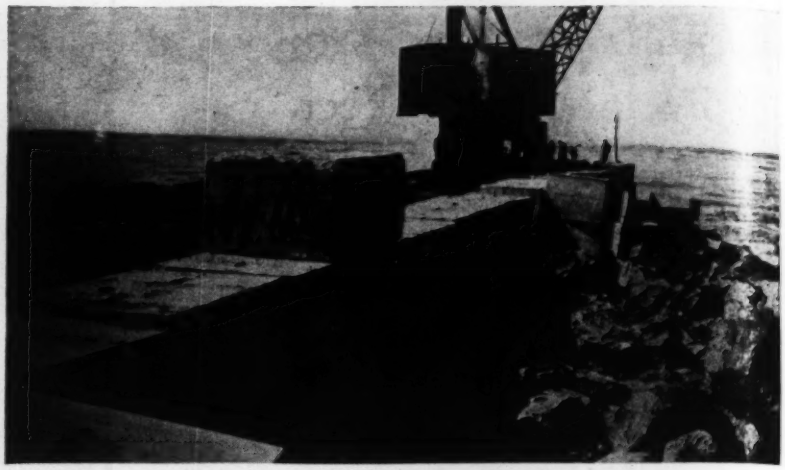


FIG. 5—CONCRETE BLOCK WALLS placed by crane are used as forms for central concrete monolithic crown of jetty.

FIG. 6—END WALL for crown block form was removed and erected ahead as each monolith was completed.

Rock Island, Ill., Repairs Old Water Basin

For the first time in 37 years of continuous service, repairs were recently made on the sedimentation basin of the municipal waterworks at Rock Island, Ill. Using relief labor, the sloping brick sides of the 5-m.g.d. basin were relined with a concrete facing, the total cost of which was $2,890. More than 200 men were employed from one day to two weeks, with a total labor outlay of $1,639. The fact that this basin required no maintenance in such a long period of time is notable.

Large Model Aids Study of Bonneville Project

Hydraulic features of Columbia River above and below Bonneville Dam site duplicated—Predetermination of river action governed design of important dam features

By Henry W. Young
Portland, Ore.

GUESSWORK is being eliminated in connection with the construction and subsequent operation of the Bonneville power project. To this end, one of the largest and most complete hydraulic models of a riverbed ever attempted has been built on the bank of the Willamette River near Linnton, Ore., and is now the scene of exhaustive experiments.

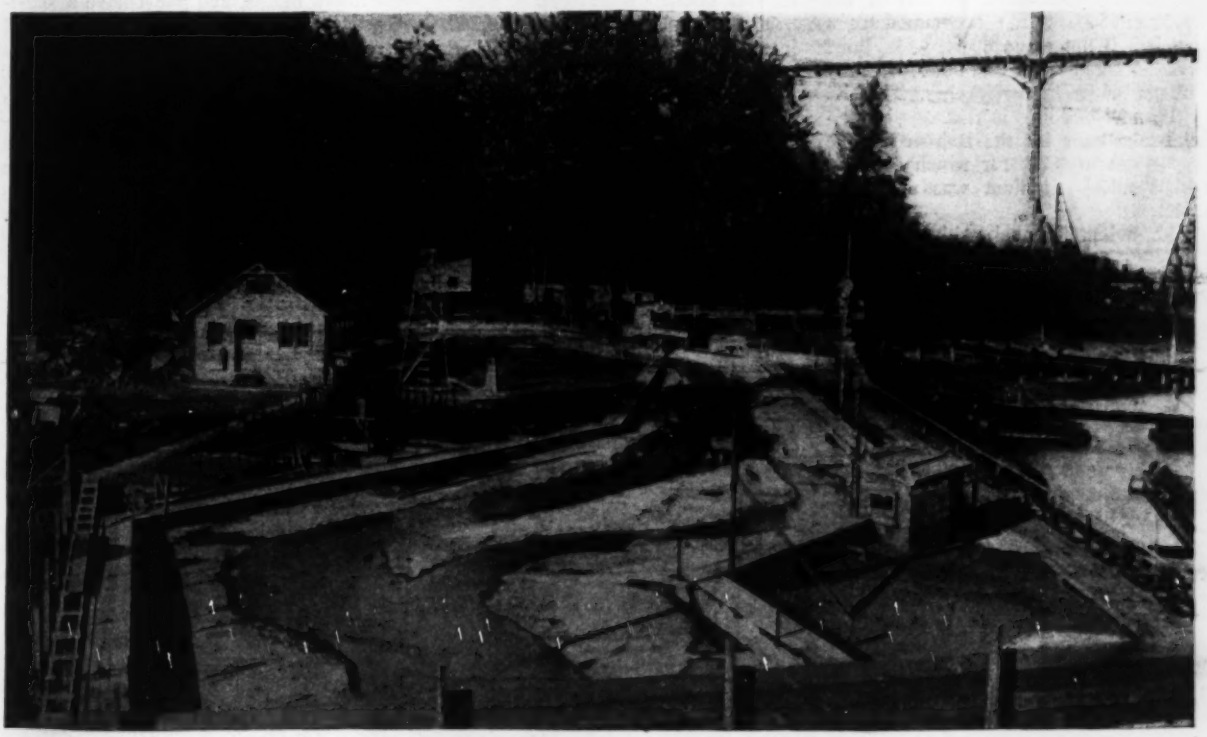
These experiments will predetermine with accuracy: (1) the action of the Columbia River at Bonneville in connection with the building of the cofferdams necessary to the construction of the main spillway dam, saving large amounts in construction cost usually attendant upon such work, because of unforeseen obstacles; (2) the ecomonic extent to which it is advisable to clear obstructions from the river channel above the dam, in order to reduce the backwater effect, and consequently the unnecessary overflow of valuable lands far up the river; (3) the scouring action below the spillways and the design of the proper baffles to prevent undermining of the spillway aprons and serious damage to the dam; (4) deposition of silt below the dam and the necessary steps that should be taken to prevent this, which would otherwise entail constant dredging to maintain a channel for ships to the locks; (5) study of available heads at all stages of the river, in connection with the development of power; (6) determination of proper and adequate fishways or lifts in order to permit the free passage of salmon up to the spawning grounds, preserving the salmon industry, which yields $10,000,000 annually.

The model, with its reservoir and headworks, is 325 ft. long. Built to a scale of 1 to 100, it represents a five-mile stretch of the Columbia River, from Tanner Creek below the dam to the head of Cascade Rapids above. It is an exact duplicate of the riverbed as far as major characteristics and obstructions go.

Transverse soundings of the river were taken every 20 ft. These lines of soundings were 100 ft. apart. A sheet-metal templet was then made to scale of each line of transverse soundings, the edge, of course, being a wavy line similar to the contour of the river bottom along that line. These templets were then set in the bottom of the model excavation, with their wavy sides up, at regular intervals corresponding to the distances apart of the lines of the river soundings. The spaces between templets were then filled with sand to within 3 in. of the top and finished with concrete, smoothed off to connect the edges of adjoining templets. Piezometer outlets also were introduced at regular intervals and connected by pipes to gage houses.

This reproduced the riverbed up as far as the water would rise in the reservoir, showing up all major irregularities, such as rocks, islets, etc. As the soundings were 20 ft. apart one way and 100 ft. the other, the minor rocks, ledges, etc., did not show. Hence the model riverbed was too smooth, allowing the water to flow through relatively faster than in the river. Therefore, it was necessary to calibrate the model.

For years back, profile lines of the river's surface had been made at all stages from lowest water to flood. Owing to the friction of the water on the riverbed, these profile lines are not in general parallel. The problem in calibrating the model was, then, to introduce small obstructions all over the model bed which would cause the measured flow of the water through the model at all stages to correspond in profile lines with the profiles in the river. This was done by spattering handfuls of concrete on the model bottom, by the cut-and-try method, until these small obstructions produced the right profiles. Then the model was



MODEL reproducing five miles of the Columbia River above and below Bonneville, to determine hydraulic effects of Bonneville Dam construction.

ready for the experiments themselves.

Operating from the same control works is another model showing three bays out of the eighteen to be built in the spillway dam, built on a scale of 1 to 36. The aprons of the model spillway conform exactly to those of the dam. In the channel below these miniature spillways, rock material was introduced in sizes to correspond by scale with the materials that will be found below the dam. When water rushes through the model, this material is gouged out, undermined and scoured as it would be on the large-scale operation. The problem then was to design baffles for the lower lip of the aprons of such shape and size as to counteract dangerous scouring effect, by reducing the velocity of the water at that point. When perfected, these baffle designs will be reproduced in concrete 36 times as large on the spillway aprons of the dam. This latter model also has to do with the deposition of silt below the dam and permits of thorough preliminary study of that problem.

Water for these experiments is pumped into a reservoir from the river, and from there it is admitted to the model by weirs and baffles in quantities to correspond to all stages of the river. This water is then returned to the river from a common spillway.

The work, in direct charge of A. J. Gilardi, chief engineer of the Limerton Hydraulic Laboratory, comes under the head of the United States Engineers Office—Col. T. M. Robins, division engineer; Major C. F. Williams, district engineer; and C. I. Grimm, chief civilian engineer.

While it will doubtless cost a large sum of money through all its phases, this sum will be inconsequential compared with the savings that will be accomplished through this preliminary study.

Unusual Concrete Roof Covers British Sports Building

Large new structure at Wembley, housing pool and sports arena, is entirely of concrete—Roof is of three-hinged arch type stiffened by exterior fins

ADJACENT to the Wembley Stadium outside London, which is famous as the scene of British rugby matches and international sports tournaments, there has been constructed a new building, to house principally a large swimming pool. Known as the Empire Swimming Pool, the building is 420 ft. long and 240 ft. wide, the width being spanned by an unusual three-hinged concrete-arch roof some 85 ft. high at the center. The arena portion of the building (300x80 ft.) accommodates a pool 200 ft. long and 60 ft. wide, lined on either side by galleries built integrally with the concrete roof arches. The site of the new building is that of the artificial lake built for the British Empire Exposition in 1924, for which occasion the Wembley Stadium was also constructed.

The swimming pool, with a capacity of 650,000 gal., is capable of being decked over to take an ice-skating rink 200x85 ft. and a sports arena 300x85 ft. The building is placed 300 ft. back from the public road, the frontage being occupied by parking facilities and gardens. The old lake bed is utilized as a basement under part of the building. The whole of the lake was not built on, leaving a portion at the back of the building to be enclosed as a garden for sun bathing and outdoor recreation.

The over-all dimensions, 420x240 ft., include annexes in front and rear, which are structurally necessary to give stability to the ends of the gable walls. These annexes accommodate the entrance hall, offices, kitchens and staff quarters.

The main hall between the annexes is of uniform cross-section for its entire length. Each 44-ft. section along the length is a complete entity as far as accommodation of the public is concerned. The whole building was planned and built to a unit of 2 ft. 9 in., this being the width of the spectator's terraces. This unit and multiples of it are carried throughout for widths of rooms, doors and windows. Vertically the unit of construction is 3 ft. The subdivision of these dimensions into 11 and 6 in., respectively, gives the limiting tread and rise of stairs allowed and produces also the pitch of the gallery.

The building is entirely of reinforced concrete. Floor slabs are of a standard thickness of 6 in. over spans of 22 ft. without beams, and walls have a standard thickness of 9 in. The walls and roof of the main building are in the form of a three-hinged arch of 236½-ft. span, the necessary stiffening of the roof being effected by ribs that produce a fin-like effect on the exterior. The main fins or stiffening ribs of the roof are 21 ft. deep and 9 in. thick immediately over the side walls. As may be noted in the illustrations, the fins are carried

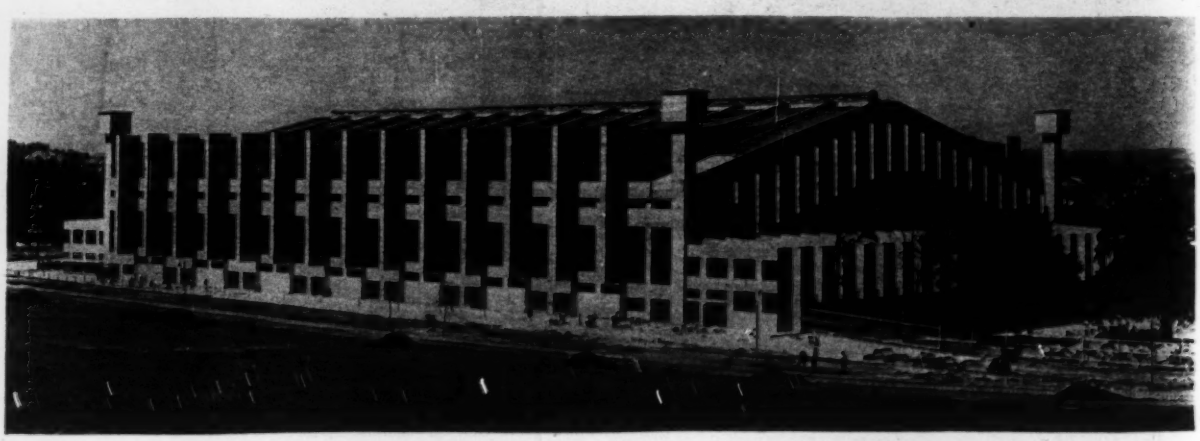


FIG. 1—REINFORCED-CONCRETE building of three-hinged arch type which houses new swimming pool at Wembley, England. Fins are stiffening ribs for roof.

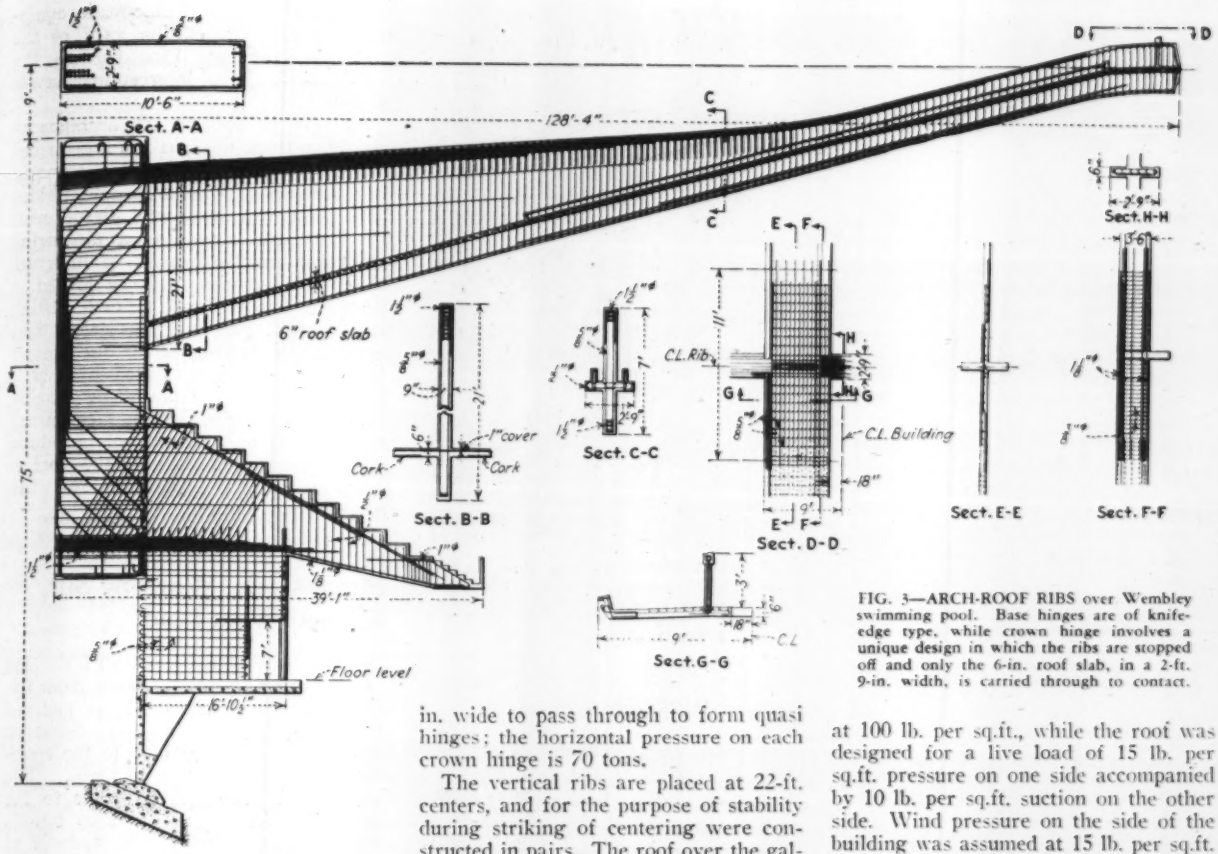


FIG. 3—ARCH-ROOF RIBS over Wembley swimming pool. Base hinges are of knife-edge type, while crown hinge involves a unique design in which the ribs are stopped off and only the 6-in. roof slab, in a 2-ft. 9-in. width, is carried through to contact.

down the side walls to a point below the gallery connections.

The galleries, lavatories and buffet bars are all integral parts of the roof. The bottom hinges of the roof are knife-edges consisting of a 6-in. width of concrete and carry a load of 22 tons per linear-foot. At the crown hinge the stiffening ribs are cut away, leaving only horizontal slabs 6 in. thick and 2 ft. 9 in. wide to pass through to form quasi hinges; the horizontal pressure on each crown hinge is 70 tons.

The vertical ribs are placed at 22-ft. centers, and for the purpose of stability during striking of centering were constructed in pairs. The roof over the galleries is a solid concrete slab lined with cork, while for most of the remainder of the roof, glass on steel purlins is utilized.

A concrete mix in the proportions of 1:1½:2½ was used throughout, giving a minimum 28-day strength of 5,920 lb. and a maximum of 7,420 lb. The basic working stresses in the concrete were 1,200 lb. per sq.in., with the reinforcing steel figured at 18,000 lb. per sq.in. Floor and gallery loads were assumed at 100 lb. per sq.ft., while the roof was designed for a live load of 15 lb. per sq.ft. pressure on one side accompanied by 10 lb. per sq.ft. suction on the other side. Wind pressure on the side of the building was assumed at 15 lb. per sq.ft.

The Empire Swimming Pool building was designed by Sir E. Owen Williams, for whom H. Iorys Hughes was assistant engineer and A. H. Clark resident engineer. The general contractor was Holloway Brothers, Ltd.

FIG. 2—INTERIOR OF SWIMMING POOL and sports arena building at Wembley.

Progress on Activated-Sludge Plant at Providence, R. I.

The third primary settling tank for the 52-m.g.d. sewage-treatment works of Providence, R. I., was put into use on June 11. Two bar screens, two detritors, two primary and five final settling tanks have been in use since May, 1931. All of the settling tanks are equipped with traction sludge scrapers. Work on the aeration tanks is in progress. There remains the installation of pumps, blowers and part of the air mains. Meanwhile, as for four years past, the sewage is being clarified.

The settling and aerating tanks have been remodelled from the old chemical precipitation tanks. The old chemical building will house the blowers.

Lime treatment of the sewage was discontinued on Feb. 1, 1934. Bichlorination with hypochlorite, begun in 1911, has been continued ever since, using bleaching powder until 1917 and the liquid form (10 per cent chlorine) since. J. W. Bugbee is chemist of the sewage-disposal works.

From Job and Office

Compact Drill Carriage for Small Tunnels

A DRILL CARRIAGE of unusually compact form was built for construction of the Mono Craters tunnel, to extend the source of water supply brought to Los Angeles through the Owens Valley Aqueduct. Not finding standard equipment that just suited their need, engineers of the Los Angeles Bureau of Water Works and Supply developed the carriage described in the following, which has proved to be highly effective. Two units are in service in the east and west portal headings of the tunnel, and four more are to be built.

Essentially the drill carriage consists of a frame made of pipe mounted on 24-in.-gage trucks. It carries adjustable supports for four drifter drills, an air receiver, folding side platforms for the workmen, and convenient air, electric and water connections, with necessary storage for tools commonly used at the face.

With the working platforms folded up in position for moving, the over-all dimensions of the drill carriage are 4 ft. wide, 6 ft. 10 in. high, and have an over-all length of about 11 ft. Principal members of the steel frame are made of 4½-in. extra heavy pipe. Four of these constitute the horizontal members of the carriage frame and extend at the forward end to serve as cantilever supports for the four drifter-drill mountings. Each drill is mounted on a short length of pipe attached by clamps to one of the four longitudinal pipes of the frame. This mounting permits each drill to swing in two planes by merely loosening nuts of the clamps. Centrally mounted in the frame is an air receiver 15 in. in diameter and 5 ft. long with six connections, one for each of the four drifter drills and two for jackhammers. The working platforms on the sides, which fold up against the frame of the carriage when not in use, have plank floors 24 in. wide. (Planks are considered less slippery than metal floors.) These planks can be slid forward to give access to the advanced position of the upper drills. The working platforms are drawn up into the folded position by ⅛-in. cables operated by a hand crab. Longitudinal pipes of the main frame have been found to be excellent storage space for the wooden tamping sticks and blow pipes. The short pipes at the drill mountings are convenient places for keeping spanner wrenches, which are used extensively around the drills.

A feature of the under-carriage is that at the front end the weight is carried on a four-wheel truck equipped with a king pin so it will take switches readily. At the rear, where there is much less weight, a single pair of wheels is used. This six-wheel arrangement not only makes the carriage easy on tunnel tracks, but the very short, rigid wheel base facilitates getting it over any switch angle likely to be used. The frame of the carriage is bolted to the rails when the drills are in use.

FRONT VIEW of the drill carriage with three of its four drills mounted. Note that combination of drill mounting and the short-pipe mounting allows each drill to swing in either of two planes.

Scoop Wheelbarrow Measures Aggregates Accurately

AN END-DUMP, scoop-shaped wheelbarrow designed for accurate measurement of concrete aggregates is an unusual piece of home-made equipment used at the casting yard of the Easterday Concrete Pipe Co. on the Cumberland, Md., intercepting sewer project.

As may be seen in the accompanying illustration, the barrows are formed of a curved piece of sheet iron, trimmed to a scoop nose, with a straight welded back piece. A horizontal tierod near the front end serves as a measuring guide for exactly 2 cu.ft. of material. When this amount is to be loaded, a light wooden bulkhead (shown resting on the two barrows) is placed face against the front side of the tierod. Occasionally a 1½-cu.ft. measurement is desired. This is obtained by placing the bulkhead within the pan, face toward the rear, with a hook bolt catching against the tierod, to give the correct position of the bulkhead for the measurement desired.

HOME-MADE WHEELBARROW for accurate measuring.

Pump Cases, Worn by Silt, Relined With Lead

THE WATER SUPPLY for Boulder City, Nev., comes from the Colorado River, whence it is pumped into a settling basin and delivered against a head of 2,300 ft. to the treatment plant on the edge of town. The pumps that deliver river water to the settling basin are required to handle water whose turbidity sometimes is as high as 140,000 p.p.m. and averages about 30,000 p.p.m. The total of suspended solids, silt and sand, sometimes reaches 87,000 p.p.m. and averages 17,500 p.p.m. In other words, suspended solids sometimes amount to 725,000 and usually average 145,000 lb. per million gallons of water pumped. Under these conditions the wear on pump cases is very great. Experiment has developed a simple and effective means of recon-

ditioning the cases, however, as described in the following.

The river water is handled by pumps rated at 750 g.p.m. against a 115-ft. head when driven at 1,760 r.p.m. The original pumps are used until the cast-iron cases become so worn that delivery is only about 65 per cent of rated capacity. The pumps then are taken out of service and reconditioned in the Boulder City shops.

The original cast-iron case averages 450 hours of service, after which it is relined with bronze at a cost of approximately 95 per cent of a new case. The bronze lining gives an average of 650 hours of service, or 44 per cent more than the original cast-iron case. When the bronze lining is worn down to a thickness of about $\frac{1}{8}$ in., the pump is again taken out of service, and the casing is built up by wiping the worn places with lead. This lead lining costs about 20 per cent as much as a new case and gives an average service of 410 hours, or 91 per cent of the average wear from the original case.

This plan of using a lead lining after a bronze base has been provided has become standard practice for the Boulder City system. In wiping the worn bronze casings, if spots are found where the bronze has worn through to the cast iron, such places are built up with bronze before the lead wiping is put on. A soft bronze welding rod is used, and common wiping lead or solder for the soft metal finish. Relining with lead can be continued indefinitely.

The water supply for Boulder City is operated under the supervision of D. M. Forester, sanitary engineer, under the general direction of Walker R. Young, construction engineer, U. S. Bureau of Reclamation.

Melting Ice Lowers Telephone Ducts

FACED with the necessity of lowering 3,200 ft. of telephone ducts 30 in. along Flatbush Ave., Brooklyn, N. Y., because the city planned to lower the street level some 3 ft., the New York Telephone Co. resorted to the use of ice cakes as lowering jacks. The melting ice provided gradual and uniform lowering as contrasted with jacks whose use previously had resulted in cracks and breaks in the ducts.

The ducts were in 400- and 500-ft. sections, each made up of nine vitrified clay and two wooden conduits, inside of which were the telephone cables or wires. Each section weighed about 50 tons.

One section was lowered at a time. At intervals of 6 ft., holes were dug for 100-lb. cakes of ice, which were packed in securely. The cakes of ice were 10 in. high. When the section had sunk to a depth of about 8 in., the remaining ice was taken out, and the operation was repeated with new cakes of ice until the section had sunk the required 30 in.

ICE CAKES being installed under telephone duct. Melting of the cakes lowered a 50-ton, 500-ft. section 30 in. without cracking it.

Some 60,000 lb. of ice was required for this work, which took eight weeks to complete. H. C. Young, superintendent for the New York Telephone Co., was in charge of the work.

Topography of Brushy Slopes Taken from Opposite Hillside

By Daniel McFarland
Civil Engineer, Arcadia, Calif.

SURVEYING country that is heavily covered with brush usually involves considerable brush cutting and consequent expense. Often most of the brush cutting can be eliminated without loss of accuracy by changing the method. In preliminary surveys for the San Gabriel project of the Los Angeles County Flood Control District it was necessary to make topographic surveys of reservoir sites for three large dams, for thirteen debris dams and a quarry site. At several of these locations, where heavy brush was 3 to 10 ft. high, with very few trees, it was found that a topographic survey could be made by locating the transit men on the hillside opposite the one to be surveyed, thus enabling them to see over the brush. When the distances were not too great, one transit was used and the work was done by stadia.

Where distances were too great for accurate stadia work, and where accurate results were required, as in the survey of the quarry site, two transits were used. In the ordinary reservoir survey several rodmen were used. The target was set a given distance from the bottom of the rod (usually 10 ft.), so that elevations could be computed easily. Each rodman had a distinguishing target, to avoid confusion as to which rod was being read. The two transitmen set their watches together and recorded the time of the readings, so they could check on the identity of the readings, when they compiled these for the office work.

In the survey of the quarry site the work had to be done in much greater detail, and the rodmen were kept on a contour with the aid of a levelman, who was also on the opposite hillside. The two transitmen had stations on little ridges, or spurs, on the opposite hillside about 1,000 ft. apart. These two stations commanded a view of an area that took a week to survey. A rubber-covered duplex telephone wire was laid on top of the brush from one transit station to the other. Two portable telephones with batteries, but without ringers, were used. The recorder was stationed at one transit point. He received his data directly from the transitman near him, and over the telephone from the other transitman. He recorded these opposite each other, to avoid errors from using readings that were not simultaneous. It was found that computations were simplified when the horizontal angles were read from the right. That is, one transitman read his angle to the right, from the other transit station to the rodman, and the other also measured the angle to the right by reading the angle between the base line *extended* and the rodman. In this way the third angle of the triangle was obtained in the office by subtracting the two field angles.

The computations were made by means of a large slide-rule, using two glasses. The glass carrying the line was set at the number representing the length of the base line, and was then held in place with adhesive tape. Using the line scale, one angle was set under this, the other glass slide was moved to the other angle, and the distance read.

Device for Vibrating Molds for Concrete Test Specimens

By R. W. Bailey
Concrete Vibrator Equipment Co., Philadelphia, Pa.

FOR accurate laboratory comparison it is essential that concrete cylinders for testing shall receive identical treatment in their preparation. With the ordinary methods of compacting and rodding the concrete by hand, too much variation occurs as a result of the uncertain human element. As a result, compression tests in a laboratory may not be reliable, and as between different laboratories the variations make intelligent comparisons even more difficult.

To obtain test cylinders which would automatically have received identical treatment in the process of casting, R. B. Gage, chemical engineer, New Jersey state highway department, experimented with several methods for placing the concrete in the molds. His studies convinced him that if the concrete, while being deposited in the molds, could be subjected to uniform vibratory treat-

LABORATORY VIBRATOR for preparing uniform concrete-test specimens used by the New Jersey state highway department.

ment, the variable human factor would be eliminated.

Obviously, the vibrated concretes would produce higher compressive strengths than concretes not vibrated; on the other hand, when cores from a job-placed concrete of known ingredients were compared with laboratory cylinders manufactured by the application of a predetermined amount of vibration, a definite relationship could be established.

The writer had the privilege of cooperating with Mr. Gage in the design of the final vibrating machine. As shown in the accompanying view, it consists of a flat steel table mounted on resilient supports. Attached to the under side of the table in suitable bearings is a through shaft on which are mounted several eccentric weights. These are so arranged that the magnitude of the centrifugal force can be quickly adjusted to accommodate various conditions. The shaft is revolved by an electric motor of the constant-speed type, at about 4,000 r.p.m.

The table is provided with clamping devices, to hold the cylinder molds firmly in place, so that all of them receive similar vibratory treatment. Both steel and paper molds can be used. With the vibrations in operation, the cylinder molds, mounted on the table, are filled simultaneously but gradually over a period of less than a minute. The motor is then stopped, the tops of the molds are struck off and troweled, the cylinders with their base plates are removed to the curing bins, and the table is ready for the next series.

The uniformity and reliability of the results obtained have been most satisfactory.

For making briquettes Mr. Gage has a smaller device essentially similar to the cylinder vibrator, on which the briquette molds are placed and vibrated while being filled.

* * *

Job and Office Notes

CELLULOID for mounting blueprints is inexpensive and also stands the rough usage that prints receive when used in a shop or factory. The best and cheapest method for mounting is the method used by photographers for mounting negatives on glass. Cover the surface of the celluloid with amyl acetate spread on with an ordinary brush, and as soon as the surface becomes sticky apply the print, using an ordinary rubber roller to spread it on smoothly. The action of this chemical on celluloid is practically the same as adding more celluloid to what we already have. Therefore the paper is actually bonded to the mounting and is irremovable.

CHARLES R. WHITEHOUSE.
Boston, Mass.

Letters to the Editor

A Rusted Bridge Under Heavy Load

Sir—It is interesting to see what loads an old iron bridge will carry after years of deterioration. A 49-year-old wrought-iron girder bridge is being replaced near Mount Carmel, Hamden, Conn. Much of the metal has been corroded away, and the bridge gives every evidence of weakness. Some years ago additional wooden supports were placed under the floorbeams, and the bridge was posted for a maximum load of 3 tons. Yet, just before the bridge was swung into a temporary position to be used during the construction of the new bridge, a 16-ton truck passed over it, *after* the wooden supports were removed. The truck was driven slowly along the center line of the 50-ft. bridge.

Each girder is composed of a 51x¼-in. web plate and 3½x2½x$\frac{7}{16}$-in. flange angles, but the inner angle of the bottom chord is badly corroded. Near the point of maximum bending moment this angle is entirely gone, yet the tensile stress developed in the remaining angle was only 15,700 lb. per sq.in.

The outstanding legs of the 3½x2½x$\frac{7}{16}$-in. end stiffening angles are gone; but the outstanding legs of the 2½x2½x¼-in. stiffening angles 10 in. away carried the maximum reaction, with a developed stress in bearing of 20,600 lb. per sq.in.

The ¾-in. flange rivets in the end panel are 6 in. apart, but under the load of the truck the developed stresses in shear and bearing were only 1,600 and 7,500 lb. per sq.in., respectively.

Considering the small sections used and the subsequent corrosion, it seems remarkable that no greater stresses were actually developed. Are we using factors of safety that are too large?

CARLTON T. BISHOP,
Associate Professor of Structural Engineering, Yale University.

July 15, 1935.
New Haven, Conn.,

The Appalachian Highway

Sir—Allow me to compliment you upon your editorial, "The Appalachian Parkway," on p. 131 of your July 25 issue. It seems to me that, in addition to the considerations which you have mentioned, some thought might well be given to the hiker whose enjoyment is greatly marred by main highway development through the scenic areas. Having recently driven over the Skyline Drive in Virginia, I feel that the desirability of the ridge trail for foot or horseback travel is greatly reduced.

I question whether the general public driving along a road such as this gets enough benefit to justify either the cost or the interference with the pleasure of the hiker. Riding in a closed automobile gives little in the way of "health, open air and intimacy with nature." Everyone I think would be much better served by having highway construction arranged to furnish reasonable access to scenic country but keeping the roads off the mountain peaks.

ROBERT S. MOULTON.
Boston, Mass.,
July 30, 1935

Economic Theory of Highways

Sir—The editorial in your issue of July 18, entitled "Protecting an Investment," is interesting and timely. There seems, however, to be little visible interest among highway engineers in the development and use of formulas and data for the evaluation of the economic factors which should govern the design of all highways, and especially, of course, the expensive modern trunk-line highways.

Highway engineers give some consideration to traffic statistics, but I think they do not yet pay sufficient heed to *traffic capacity* and the effect on this of limiting curvature and gradients, traffic delays from grade-crossings, lights, drawbridges, etc.

The writer made an attempt some few years ago to determine the value of these factors as they might influence the design of New Jersey Route 25 between the Holland Tunnel and Elizabeth. The results are set forth briefly in the paper "Highways as Elements of Transportation," published in Vol. 95 of the *Transactions* of the Am.Soc.C.E. Some sporadic attempts have been made since then along similar lines, but the development of an "economic theory" of highway location and design seems to lag far behind the development of highway expenditures, which should be governed, or at least tested, by the application of such a theory.

The general adoption of such a "theory" by the railways was, of course, influenced by their commercial and profit-making character, but it is none the less the duty of engineers to bring this to bear on highway design where vast sums of public moneys are involved. The economic gain or loss is there, whether reflected in a balance sheet, as in the case of the railways, or in a few cents saving or extra cost in the operation of individual cars, multiplied in many cases by a good many millions of cars per annum.

I think we cannot insist too strongly on the development of knowledge of these factors and their application.

New York, N. Y., July 29, 1935. **F. LAVIS.**

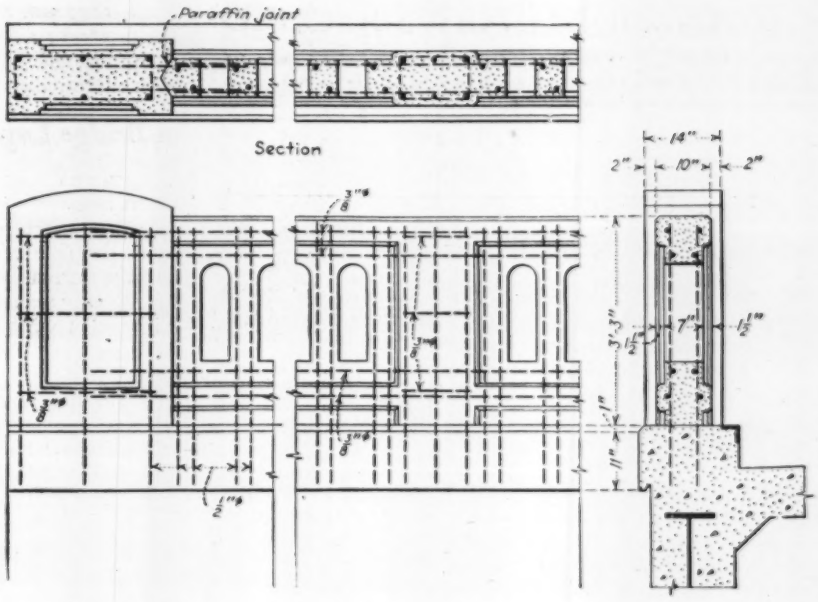
Safe Bridge Railings

Sir:—On p. 887 of your issue of June 20, 1935, Mr. Johannesson, designing engineer of the New Jersey state highway commission, discusses highway bridge safety with regard to accidents caused by motor vehicles crashing through bridge railings, a subject deserving of much more consideration than it apparently is receiving at the present time.

Many of the bridge railing types that have appeared recently seem to have been designed with more regard to architectural than structural considerations. While the architectural treatment of a bridge railing is properly of importance, its structural adequacy is more important.

The present-day fast-moving loaded truck or bus constitutes literally the renowned irresistible force. However, it is not generally practicable, nor is it necessary, to design the bridge railing to be an absolutely immovable object. The problem is simply to devise some means of keeping the vehicle on the bridge.

The high curb suggested by Mr. Johannesson may very probably be the solution of the problem for bridges on rural roads or on trunk highways, but it does not seem suitable for bridges in urban or suburban districts, where existing street widths, grades and curb heights must be taken into account and where it is essential that the railing present a pleasing appearance, principally from the roadway side.



STANDARD RAILING used on bridges in Mercer County, N. J.

In Mercer County, N. J., there has been developed and used for several years, with slight modifications from time to time, a bridge railing of good appearance that has proved to be structurally adequate. It is not, and cannot be, immovable under the impact of a heavy fast-moving vehicle, but it is of sufficient strength to prevent the vehicle from crashing completely through the bridge railing to the stream or roadway below.

The accompanying figure shows the details of the design. Pairs of vertical rods at about 10-in. centers, anchored into the fascia girder, and longitudinal rods from joint to joint, form a continuous mat of anchored steel rods which may give under severe shock but will not fail entirely. Particular attention is called to the dowels used at expansion joints, in order to provide for shear.

Trenton, N. J., June 22, 1935. LESLIE R. SCHUREMAN, Bridge Designer, Mercer County Engineer's Office.

Fineness Modulus

Sir—I have had occasion to investigate the use of the fineness modulus in connection with selection and blending of earth materials for rolled-fill earth dams, and may be able to answer some of the questions raised by Lt.-Col. F. S. Besson in your issue of Feb. 14, 1935, p. 248, and by P. Dekker in his letter in your issue of June 13, 1935.

A distinctive feature of the fineness modulus as developed by Abrams is the use of the alternate sizes of the Tyler standard sieves. This automatically segregates granular material by particle diameters each twice the size of the next smaller. Prof. Abrams commenced his series with the No. 100 mesh screen because most aggregates are completely held by this size. Another modulus beginning with a smaller mesh could be developed, however, which would have the same property—namely, that the sum of the percentages held on various sieves divided by 100 would give a value that is a function of the average diameter of particles. A modulus similar to the Abrams fineness modulus could thus be devised that would be representative of fine as well as coarse particles, thus meeting the objection raised by Colonel Besson.

A modulus of this character is a very valuable aid in the study of materials for aggregates, especially in making calculations for percentages when combining two or more materials to make a denser aggregate. To obviate the difficulty, pointed out by both your correspondents, of there being an infinite number of aggregates representative of any fineness modulus, it is necessary to define the size distribution desired in the combined aggregate. This is accomplished by use of a grading formula, either the Fuller grading curve or the more general Talbot grading equation $p = (d/D)^n$, where p = the proportion by weight passing a given sieve opening, d = size of opening, D = maximum particle size, n = an exponent which can be varied according to the fineness or coarseness of grading desired. There is but one aggregate which can represent a fineness modulus when used in conjunction with a grading equation. Furthermore, the computations are very simple, avoiding the tedious detail of other methods.

CHARLES H. LEE, Consulting Engineer.

San Francisco, Calif., June 24, 1935.

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August 8, 1935

Principle Cast to the Winds

IN THE NAME of charity, which traditionally covers a multitude of sins, the Works Progress Administration with the President's approval is undertaking to build sewage-disposal plants for Atlanta and its surrounding county. With this action the federal government casts principle to the winds and extends an open invitation to exploitation of the Works Program fund by local communities desirous of "getting theirs" from the federal treasury. Already demands are coming in from other cities that see no reason why a $4,000,000 gift should be handed to Atlanta unless they likewise are permitted to profit; and, in fact, is there any reason why the rest of the South, or the North and West, should pay for Atlanta's civic improvements without receiving a *quid pro quo?* The inference that principle has broken down in the WPA is confirmed by the report from Washington that it is preparing to take up local budgetary work quite generally, which will open the door for exploitation still more invitingly and in addition will demoralize city organizations and procedure. These events constitute a confession of failure on the part of the WPA and convict it of incompetence and lack of vigor in prosecuting its work.

Bridge Tentacles

CONTEMPLATION of the present state of the art of highway bridge design provides an illustration of how much more frequent are improvements in details than in fundamental concepts. Thus, the short and medium-span bridge was an ultra-modern structure in every sense before there was general recognition that it must be planned as an integral and uninterrupted part of the road in width, surface, gradient and curvature. Many fine but narrow and dangerous structures were built before this concept was accepted as basic. In the field of the long-span major structure the disproportion of detail to fundamental improvement is even more marked. As recently as a decade ago the opening of the Delaware suspension bridge gave the world one of the most remarkable examples of structural advance in history, yet the bridge was merely another structure, joining a principal street in Philadelphia with a principal street in Camden. Philadelphia has since learned that that principal street is a bottleneck for heavy traffic, seriously reducing the efficiency of the bridge. The concept that a great new bridge must be planned and built as a link in an extensive system of collecting and distributing roads was first recognized by the designers of the George Washington Bridge in New York. Currently, it is finding expression on two great structures separated by the width of the United States—San Francisco's Bay Bridge and New York's Triborough Bridge. The latter represents the present zenith of such planning, with its 14 miles of connecting roads in the three boroughs that it serves. The modern tendency to build great structures as revenue-producing enterprises has no doubt fostered the acceptance of the idea of getting a maximum of traffic onto and away from a bridge. But regardless of the motivating force, the logic of the change can hardly be questioned. Future great bridge projects will probably extend their tentacles even farther afield.

A Bridge Engineer Departs

WHAT THE ART of bridge engineering has lost in the death last week of Gustav Lindenthal is not easily estimated at short range. He had long stood forth as almost the sole remaining link between the present day and the formative years of the bridgebuilding art, when a beginning was made toward developing it to full flower. Lindenthal with his powerfully marked personality had perhaps more than any of his colleagues of the early days the gift of imagination. A broad grasp of every problem that came to his hand and an unerring engineering instinct joined to a truly artistic sense of form distinguished his thinking. From his entry into American engineering in the design of buildings for the Philadelphia Centennial Exposition of 1876, down to such works as the Sciotoville and Hell Gate bridges, he displayed an originality and fertility of conception that at all times was an inspiration. He was the antithesis of the stress-sheet engineer; a master of economy in design, he yet was a champion of adequate strength able to meet the manifold demands of the future. And at the same time he was a pioneer in bringing esthetic bridge design to the fore. More than three decades ago he drew architects into collaboration in his major designs. He would have attained greatness in other fields; his work in company with Samuel Rea in developing the New York Connecting Railroad project, and his later studies of rails and car-bearings, are proof of this. But bridge engineering was his career. What he contributed to its advancement is expressed both by his own works and by that of his disciples who are building bridges in the service of a new era.

Setting the Pace

THE NEW Southwest treatment plant of the Chicago Sanitary District deserves attention not only because it ranks as the largest activated-sludge plant in the world but also because it will be the embodiment of the latest advances in sewage disposal. Only major structures such as this one make possible the exhaustive investigations so necessary for comprehensive evaluation of processes and their essential operating details. Interest attaches to the use of 16-in. air-lifts for the sludge draw-off in the final settling tanks and the relatively simple plant design that resulted from the use of sewage and sludge channels of the same depth as the aeration tanks. By far the most significant feature, however, is the plan to use a sludge-incineration process for waste-heat utilization in conjunction with a steam-generating unit that will operate pumps, blowers and house generators. Disposal of sludge by dewatering and incineration as contemplated at Chicago seems at present to be the most promising solution of a troublesome problem, particularly when large volumes must be dealt with. In addition, size and cost of the plant are considerably reduced because incineration needs only a fraction of the area occupied by digestion tanks and air-drying beds; this explains why the Southwest plant can be accommodated on land originally purchased and earmarked for the extension of the present West Side works. The Chicago Southwest plant is pointing the way toward new economy in sewage disposal.

By Mechanization and System

WHEN the New Jersey shield of the Midtown Tunnel at New York holed through into the Manhattan shaft on Aug. 2, soft-ground tunneling by shield and compressed air was formally raised to a new level of achievement. Speed of shield advance was increased by more than one-half as compared with prior performance; the high figures attained, 47½ ft. in one day and 1042½ ft. in a single month, are far ahead of those reached in the Holland Tunnel and the Pennsylvania Railroad tunnels. And, as with its 32-ft. shield the Midtown Tunnel is larger than either of its predecessors, it was a more difficult undertaking.

Appraisal of this noteworthy contribution to the art, accomplished by advanced mechanization of the job and thorough systematization of its working operations, must consider the relation of tunneling under the Hudson River to the peculiar characteristics of the river-bottom soil in the New York City reach. Speed records such as have just been recorded would be out of the question in other kinds of soil.

The fine, plastic clay-like material long known under the name of Hudson River silt has many strange properties. It is a sticky, plastic mass that handles like clay but easily breaks down into a slurry when disturbed. Around and back of the tail of a tunneling shield, therefore, it is apt to become disorganized, and it has been known to flow through a small hole as a liquid jet.

Ordinarily, when a tunnel is driven through clay, the clay must be excavated at the face before the shield can be forced forward. In early tunneling under the Hudson the silt was excavated by the methods usual in clay. But when the Morton St. tunnels were being pushed to final completion something more than thirty years ago, the surprising fact was observed that the shield with all doors closed could be shoved forward into the silt without excavating—by crowding the silt out of the way.

This was a new discovery. It was put to practical use shortly afterward in the 33rd St. tunnels of the Pennsylvania R. R. In the latter work it was found that "blind" shoving of the shield—that is, shoving with all shield doors closed—played havoc with the tunnel by forcing the shield behind it upward. Then, however, it developed that by opening one or two small gates in the shield diaphragm and letting a part of the displaced silt flow into the tunnel as the shield was shoved forward, satisfactory control could be maintained. This was the method that was used with great success in the remainder of the Pennsylvania Railroad tunnel work, where a single day's advance of 37½ ft. was reached on a special occasion, and fifteen years later with still more consistent success in the driving of the Holland Tunnels, where a speed of 25 ft. in a day was recorded.

Working under precisely the same conditions and using this identical method, the contractors for the Midtown Tunnel took studied advantage of the peculiarities of the Hudson silt soil. Taking in just enough silt to supply a desirable amount of ballasting in the tunnel tube back of the shield, and arranging a trough containing an apron conveyor back of each silt-admitting door, to carry the incoming prism of silt some distance back and deposit it in the lower quarter of the tunnel tube without interfering with operations at the shield, they eliminated the problem of spoil removal.

There remained one further limit to rapid advance; the rate at which additional rings of lining could be erected behind the advancing shield. Setting up these rings of cast iron, weighing many tons and requiring the insertion and tightening of a large number of heavy bolts, was an operation whose limiting points were the time lost in bringing forward, picking up and placing the heavy ring segments, and in the slow business of tightening up the nuts on the numerous large bolts. It was speeded up by a carefully planned layout of trackage and working routine for bringing the segments to the shield, an ingenious hook on the hydraulic erector arm by which a segment could be picked up without the loss of a moment and swung into position for bolting, and, most important of all, a hydraulic bolt-tightening machine, which in a single operation could turn up the nut on a bolt and tighten it to full working tension without overstress.

It was these and various auxiliary features of equipment, coupled with painstaking assignment of duties to the individual men and gangs in the tunnel, that made the Midtown Tunnel speed possible. Without essential change in construction process, the contractor attained higher efficiency by systematic study of detail procedure and by the development of new mechanical aids where these were applicable. As an achievement of efficient construction management the Midtown Tunnel should long hold a place in the records of construction.

New York's Insularity

THE PASSING of Gustav Lindenthal, veteran bridge engineer, inevitably brings to mind the project that formed the central motive of his life for nearly half a century, the project for a great bridge across the Hudson River to end the insularity of New York City by bringing rail freight to its doors. Born of his affiliation with Samuel Rea, later president of the Pennsylvania Railroad, in the 80's, it grew almost from the first into a plan to bring the through traffic of all the railroads terminating on the New Jersey bank into the city. No transportation problem in the country was more important, nor more difficult.

Lindenthal reported, after his first study of the project, that it was feasible. Its subsequent dramatic history is too long for recital here. Among its elements were the grant of a broad Congressional charter, a sudden check to the project when the financial storm of 1893 broke over the world, the subsequent rise of electric traction and the decision of Alexander Cassatt to carry out, instead of a joint bridge, a tunnel and terminal plan for the Pennsylvania Railroad alone; revival and continued restudy of the bridge project as a solution of the uncorrected railway transfer situation, and a succession of obstacles that blocked its progress, from the World War to personal opposition and political chicanery.

In the course of this long history of constant effort and as constant failure, new movements changed the scene. Highway transportation grew from nothingness to titanic proportions, and a vehicle tunnel was built under the river. The Port Authority was created as an agency to coordinate the freight transportation facilities in the Port of New York. Finally the George Washington highway bridge was built, six miles farther north. Throughout these changes, however, the physical separation of insular New York from its adjacent mainland territory became only the more evident.

Much altered in both kind and degree, the problem to which Rea and Lindenthal turned their study almost fifty years ago still remains. Now that Lindenthal's unremitting labor upon it is ended, the task of working out a solution falls to others.

CURRENT NEWS

Midtown Tunnel Holed Through In Record Time

A RECORD-BREAKING tunneling job was completed on Aug. 2, when the Midtown Tunnel under the Hudson River from 39th St., New York City, to Weehawken, N. J., was holed through two months ahead of schedule. The contractor, Mason & Hanger Co., averaged about 30 ft. of progress per day under the river, and as much as 47½ ft. of shield movement and 45 ft. of cast-iron tunnel lining was done in a single 24-hr. period.

Tunneling started at the foot of the Weehawken shaft on Sept. 29, 1934. The work for the first 100 ft. or so was through rock and by the end of January, 1935, the shield had reached the river silt. River bed conditions were favorable to shield operations and work reached progressively greater speed. Most of the work could be carried on under unusually low air pressure, generally only about 16 lb. per sq.in., though at depths of 90 to 100 ft.

The tunnel is being financed by Port of New York Authority bonds as security for a PWA loan of $37,500,000. O. H. Ammann is chief engineer of the Authority and Charles S. Gleim is engineer of construction. Jacob Mechanic is resident engineer on the Jersey side in charge of the tunneling. Only one tube is being built now, and it will carry traffic in both directions. Later another tube will be constructed. Although the tunneling under the river has been completed, there is still some rock tunnel to be cut on both the New York and Weehawken ends. The tunnel is scheduled to be opened to traffic early in 1938. One accident marred the progress when a premature blast killed three workers in the Manhattan heading on April 8.

The general arrangement of the Midtown Tunnel is similar to that of the Holland Tunnel (*ENR*, Mar. 8, 1934, p. 313), but its over-all diameter is 31 ft. instead of 29 ft. 6 in. A 21-ft. 6-in. roadway is provided, with 13 ft. 7½ in. clear headroom. The new tunnel will have three instead of four air ducts and there will be no ventilating shafts at the pierhead.

Contract for the New York approach to the tunnel has already been let (to Cornell Contracting Co., *ENR*, June 29, 1935, p. 891), and excavation work has already been started in the plaza. Approaches on the New Jersey side, which are complicated by the steep Palisades cliffs, have been delayed by the necessity of adapting the plans to the requirements of the several communities and authorities affected, but agreement has now been reached and construction is expected to begin shortly.

Silt-displacement method used

The silt-displacement method of tunneling, which is practically impossible elsewhere than in Hudson silt, was used in pushing the tunnel under the river. Shield operations therefore were not difficult and

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Two Bills to Halt Pollution Considered by Congress

Two bills having to do with federal action in regard to pollution of streams and waterways have recently been introduced in the House of Representatives. On July 30 a measure to prevent pollution of the rivers and harbors was referred to the Rivers and Harbors Committee. This bill would extend the control the Secretary of War has over navigable water to include the control of pollution. The Secretary would have the power to issue desist orders to anyone contributing to the pollution of navigable waters. A forfeiture of $100 per day for failure to comply with the order is provided for in the measure.

On July 31 the Rivers and Harbors Committee read a favorable report on a bill concerning the pollution of streams by federal institutions. The bill requests the President to determine the number and location of federal institutions which are depositing untreated sewage into navigable or non-navigable waters and to make recommendations that will aid in keeping the streams free from pollution.

Work On San Gabriel Dam Resumed After Long Delay

After being shut down for eight and a half months, work was resumed July 27 on San Gabriel Dam No. 1, Los Angeles, Calif., county Flood Control District project, to be completed under revised plans, contingent upon approval of the plans by the California state engineer. Approval of the plans was anticipated during the week of July 29. The Los Angeles County Board of Supervisors on July 26 adopted the revised plans for the dam, calling for a redesigned structure to be built larger than the original project and to permit the use of material for a fill that was considered waste under the original specifications. The county supervisors also authorized a supplemental agreement with the West Slope Construction Co., builders of the dam, wherein the company is to receive $239,998.48 for accrued expenses during the shut-down period from Nov. 13, last, until July 26. The company had filed a claim against the flood control district for approximately $800,000 for expenses and damages during the shut-down.

Little Progress Made in Works Program; Relief Needs Likely To Increase

(Washington Correspondence)

PRESIDENT ROOSEVELT regards calmly a relief works program that has not put anybody to work. He expects that the number employed on relief jobs, still practically zero unless the CCC is counted, will increase sharply next month and that a large majority of employables on relief rolls will be at work in October. The President is no longer thinking, however, in terms of 3,500,000 men as a peak nor of November as the peak month; the number needing relief employment may increase in the winter.

A pliant attitude with respect to termination of direct relief by the federal government is apparent. The President's intention still is to transfer responsibility for the support of unemployables to the states and communities, but if they refuse to accept this responsibility, people will not be left to starve. Harry Hopkins is, however, grimly cutting down on federal grants to the states, particularly for relief in rural districts in a season when there is no justification for the demand. Hopkins was allotted $95,000,000 in July for direct relief. Grants to the states actually totaled $21,338,974 in that month, as compared to $149,764,000 in June and $218,882,000 in May, which was the peak. The low July figure is partly accounted for by the fact that grants made in June anticipated some July needs. The August allotment to FERA totals $95,000,000. While this represents a power dive, next winter will find the administration still in the relief business. In addition to unemployables which the states do not take care of, employables must be carried on relief until transferred to relief works projects.

Actual work is slow in starting. Promises are that delay in release of funds following approval of allotments will soon be eliminated. The bottlenecks are the Budget Bureau and the Comptroller General's Office, which latter, the President explained, needed some time to set up accounting methods sufficiently comprehensive to handle the vast volume of business that has to be cleared. Some day there will be an investigation of the money spent by the Roosevelt administration and the books will be open for inspection.

Allocations to date

Allocations and allotments up to August 3, total $2,311,191,092. There is some duplication as, in the Division of Applications and Information at least, bookkeeping is impressionistic and the errors of omission and commission are difficult to explain. Allocations include $500,000,000 to the states for highway construction and grade-crossing elimination but only one state, Michigan, has had its plans approved to date. Tugwell's Resettlement Administration is down for $98,000,000, but has actually been allotted $3,400,000 for administrative expenses. Its plans for rural rehabilitation and retirement of submarginal land are well advanced, however. Tugwell is temporarily embarrassed by having too many employees, hundreds of whom were carried over from the Rural Rehabilitation Division of FERA and the Division of Subsistence Homesteads, to

(Continued on p. 207)

Secondary Roads To Be Developed With WPA Funds

ADOPTION of an extensive farm-to-market road program as one of the principal features of relief works planned by the Works Progress Administration removes any likelihood that the states will receive any further allotments for highway construction and grade-crossing elimination. The allotment of $500,000,000 to date is $300,000,000 short of the allocation made by Congress but President Roosevelt will probably stop at that figure. He has wide latitude to shift funds at will and was not pleased by the rules prescribed by Congress for distributing the highway allotment among the states.

WPA is expected to spend as much in dirt and the cheaper grades of asphalt road construction as the states have been allotted for their highway programs, of which a minimum of 25 per cent must be spent on secondary roads. Before approving the regulations governing the state allotments, the President seriously considered raising this minimum to 37½ per cent but this proposal was abandoned in favor of carrying on such road construction under WPA.

Perry Fellows, acting chief engineer of FERA, will have charge of the WPA road program. Administrators will be appointed in each state. State highway departments will be requested to cooperate in an advisory capacity only. The program will be mapped by counties on the basis of the number of men on relief rolls and the need for rural roads. It is estimated that the program will employ 600,000 men at a cost of $800 per man-year for labor and materials. Counties that contribute something to defray the cost of their projects will get preference. Money and labor will be supplied through WPA district offices.

State highway departments suspected that the initial allotment of $500,000,000 would be the last and are revising plans accordingly.

Michigan is the first state to get approval of its plans for spending its highway and grade-crossing allotments. Alabama's plans have cleared the Bureau of Public Roads and final approval is expected to follow shortly. An allotment of $6,765,197 covers elimination of numerous grade crossings in 27 counties in Michigan and represents the state's entire allotment for this purpose. An allotment of $5,498,000 for highway construction in 36 counties in Michigan leaves a balance of $803,414 to which it is still entitled. Alabama's share of the $400,000,000 allotted for highways and grade crossings covers $4,151,115 for highways and $4,034,617 for grade separation and protection.

West Haven, Conn., to Consider Sewage Disposal Plant

The West Haven Board of Selectmen has tentatively set Aug. 8 as the date for a meeting to consider the building of a new sewage disposal plant to cost about $200,000. At the same meeting the issuance of $220,000 of town bonds will be discussed. These bonds are for the development of the Savin Rock waterfront.

Ickes Denies PWA Will Modify Present Price Differentials

(Washington Correspondence)

PWA's order establishing price differentials against foreign steel that are not regarded by domestic industry as sufficient protection will stand as issued May 25. Reports were denied by Secretary Ickes that the order would be modified to permit rather than compel borrowers of PWA funds to buy foreign materials for public works if the cost of domestic materials exceeds foreign bids by more than prescribed differentials. Until Eugene Grace, of Bethlehem Steel attacked PWA recently, Horatio B. Hackett, Assistant Administrator of PWA, was favorably disposed to modifying the order and would have so recommended. Threat of foreign competition in public works program was temporarily removed this week when German sheet piling interests failed to submit an expected bid on a Miami, Fla., dock job covered by a PWA loan.

In a parting shot against Mr. Grace, Ickes asserted the Bethlehem Steel Co. owns extensive mines in Cuba and Chile, is the largest importer of foreign iron ore and imports practically its entire supply of manganese. The Ore Steamship Co., a subsidiary, has long-time charters on two German-built vessels, Amerikaland and Svealand, operating between Chile and Baltimore, manned by Swedish crews on a wage scale lower than that of American seamen. Ickes also claimed that the steel company has its own shipyards in Baltimore, Boston and San Francisco, has actively supported legislation to aid American Merchant Marine but prefers to build its own ships of steel manufactured from foreign ore, mined by foreign labor and transported in foreign bottoms manned by foreign crews. Asked whether there is enough manganese in this country to supply Bethlehem's requirements, Ickes said he might answer by asking whether there are enough sailors.

Hackett Reports New PWA Superior to 1933 Program

The new PWA program, superior in quality and speed to first public works program, is well under way throughout country, Assistant Administrator Horatio B. Hackett reported from Los Angeles to Administrator Ickes. All officers so far visited by the Assistant Administrator put the new program ahead of the 1933 work. Acting State Director, Julian Montgomery, of Texas, reported that his office is operating on day and night shifts. Col. Hackett found the decentralized PWA Administration, which is now conducting the legal, financial and engineering examinations in the field, is functioning well.

He settled numerous technical questions during his visits. Conferences were held in Columbus, Ohio: Indianapolis, Ind.; St. Louis, Mo.; Topeka, Kan.; Oklahoma City, Okla.; Forth Worth, Tex.; Albuquerque, N. M.; Phoenix, Ariz., and Los Angeles, Calif. Colonel Hackett's inspection party which is traveling 7,000 miles by plane turned northward this week to San Francisco, Portland, Seattle, Bonneville Dam, Boise City, Salt Lake City, Denver, Omaha, Des Moines, Minneapolis, Chicago and Detroit.

Land Use Program Gets Added Funds For New Projects

ALLOTMENTS of $41,250,000 to the Resettlement Administration and to the Bureau of Reclamation were approved Aug. 5, to be used in carrying out the coordinated program of reclamation and land utilization. Previously the President had approved an allotment of $12,000,000 to the Forest Service as part of the same program. This is in line with the policy of taking ten acres of land out of production for each acre that is put into cultivation through reclamation and irrigation projects.

The Resettlement Administration will use $22,000,000 to take land out of present production and develop it for other uses. The Bureau of Reclamation's share of the allocation is $19,250,000, the first part of $64,830,000 set aside as the bureau's share of the $98,830,000 earmarked for the program. The Reclamation Bureau's projects are expected to put 100,000 acres of land into cultivation within one or two years. To offset these 100,000 acres, the Resettlement Administration and the Forest Service will buy 1,000,000 acres of land for retirement and conservation. In addition, it plans to purchase at least 4,000,000 acres during the year to offset land put into cultivation through reclamation and irrigation projects during the past few years.

The Resettlement Administration, which is charged with the land utilization program, has optioned a total of approximately 11,000,000 acres over the country, of which options on 3,500,000 acres have been accepted. The Resettlement Administration is now making examination of 250 possible locations for land purchases to carry out the President's balanced program.

The projects to be carried out by the Reclamation Bureau are:

State and Project	Amount Requested
California	
All-American Canal	$15,000,000
Idaho	
Boise-Arrowrock Dam repairs	600,000
Boise, drainage	160,000
Oregon	
Owyhee project	1,500,000
Vale project	340,000
Utah	
Ogden River project	500,000
New Mexico-Caballo Dam	900,000
Other projects	
Colorado River investigations	250,000
Total	$19,250,000

Change Of Plans Will Permit Uncompahgre Drainage

A change in plans for work on the Uncompahgre (Colo.) project will permit construction of a comprehensive system of drains. Under the new order $500,000 can be applied, after suitable repayment contracts have been entered, to draining the low lands along the river. The money will come out of the original allotment of $2,725,000. The original allotment was made for the construction of the Taylor Park dam and reservoir, repair and relining of the Gunnison tunnel and rehabilitation of the canals on the Uncompahgre project. When the contract was let for the dam it was found that the bid was considerably below the estimates of the cost of the work.

Midtown Tunnel

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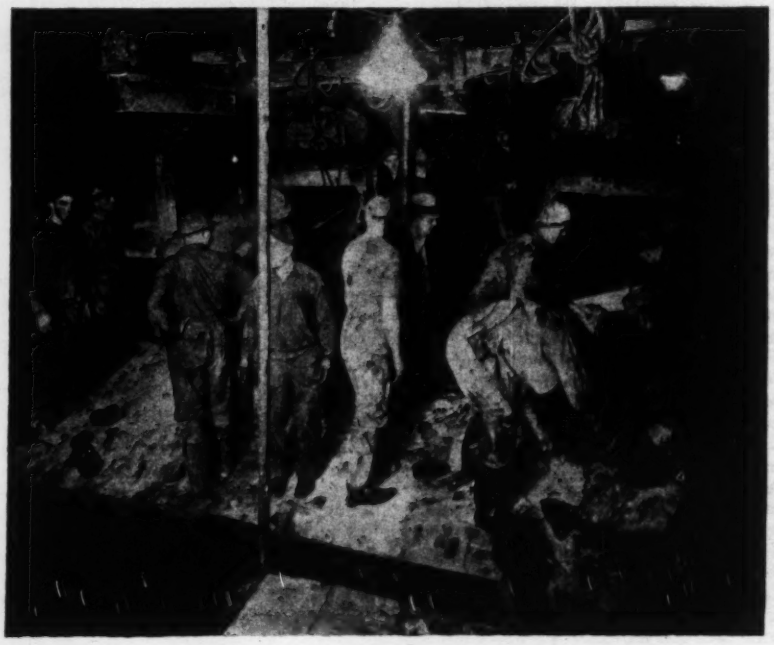
speed depended upon the erection of the lining. In order to expedite the erection of the tunnel lining the contractor systematized the work so that the least possible delay would ensue. Short sections of apron conveyor carried the silt back from the shield and deposited it behind a moving apron some 20 ft. back, leaving a substantial working area free from muck. The volume of silt admitted (through two slide gates in the shield) amounted to about 20 per cent of the displacement of the tunnel; all the spoil was placed in the tunnel as ballast, so that no removal of spoil was necessary during the shield operations. The apron behind which the silt was deposited was carried forward on a gantry frame, which also supported four hydraulic bolt-tighteners. Lining segments were carried forward to the shield by a small trolley hoist and lifted to position by the erector arm pivoted to the back of the shield. As soon as they were placed and the bolts inserted, the bolt-tighteners, operated by a hydraulic ram through a chain sprocket, immediately tightened the bolts to the predetermined initial stress. This did away with the necessity of subsequent tightening of the bolts.

Although the shield traveled a distance of 5,000 ft., survey lines run through a 10 in. pipe when the headings were about 60 ft. apart showed the survey lines to close within $\frac{3}{8}$ in. in alinement and $\frac{1}{4}$ in. in level, while the stationing checked within $\frac{3}{8}$ in. This is especially notable in view of the difficulties of survey work under continuous high-speed tunnel driving.

The Midtown Tunnel is the largest shield yet driven under the Hudson River, being 31 ft. 8½ in. outside diameter. Maximum progress per month was almost twice that of the Holland Tunnel, being a total of 1,040 ft. (June, 1935), as compared with 555 ft.

The north tube of the Hudson & Manhattan R.R. uptown tunnel was the first Hudson River tunnel to hole through (Mar. 11, 1904). Two years later the north tunnel of the Pennsylvania R.R. tunnels was holed through (Sept. 12, 1906). The silt-displacement method of tunneling was first tried in the south tube of the Hudson & Manhattan uptown tunnel but was not developed to a very great extent. When it was first used in the Pennsylvania tunnel, it proved rather disastrous. Blind displacement was used and the shield became unruly, getting out of line and causing considerable delay. Admitting of the silt was then tried and found to be more or less successful and was used to quite an extent on the Pennsylvania R.R. tunnel.

WORKMEN in the Midtown Tunnel removing silt from the apron conveyor



Engineers Begin N. Y. Flood Control Survey; Other Sections Damaged by Heavy Rains

ARMY ENGINEERS, with an allotment of $200,000 recently granted, on July 30, moved into the New York State flood area to survey for future flood control. The survey, which will cover eighteen New York counties and seven in Pennsylvania, is to be under the general supervision of Col. John Schulz, district engineer, stationed at New York City.

Capt. Lester F. Rhodes, who has been transferred from Washington to take active charge of the survey, with two assistants, made a three-day tour of the area, taking notes to aid in carrying out the work. Elmira has been selected as headquarters from which about 400 men will operate in making instrument surveys and maps. As a result of the preliminary survey it was evident that much damage resulted from the flood because bridge clearances were not sufficient to allow the debris to be carried off.

Reconstruction expedited

In order to expedite the construction work in the flood areas WPA state administrators have been authorized to distribute funds without submitting project data to Washington for approval. Both CCC and relief labor will be employed. On private property relief labor will be used exclusively as the law confines the use of CCC labor to public property.

For reconstruction work in the devastated area, the President has approved allotments to WPA of $1,000,000 for New York and $500,000 for Pennsylvania. Allotments totaling $3,500,000 also have been approved to repair damage due to recent floods in seven western states as follows: Colorado, $1,000,000; Arkansas, $750,000; Oklahoma, $550,000; Nebraska, $500,000; Kansas, $300,000; Texas, $300,000; and Wyoming, $100,000.

Flood damages of $1,589,900 in Colorado were reported to Administrator Hopkins. The report stated that 452 bridges were swept away and of this number 385 were on county roads and 67 on secondary state highways. Replacement of the 452 bridges will cost $1,477,201; additional work, $22,625; earthwork $75,450 and surfacing $14,625.

Flood damages in Arkansas during June on the Arkansas, Petit Jean, Ouachita and White rivers amounted to $1,163,650, divided as follows; loss on the Arkansas and Petit Jean, $944,750, on the White, $175,900 and on the Ouachita, $43,000.

RFC opens Elmira office

The Reconstruction Finance Corporation also established offices in Elmira to extend its facilities to the stricken area. Loans will be made to finance building sites and homes, and the repair or reconstruction of other buildings. Under a recently enacted measure for continuing emergency flood relief, individuals, corporations and municipalities are eligible to receive RFC loans, and these will be made for the reconstruction of water, gas, electric, sewer and drainage systems.

Ohio flood damage high

Floods in the Hocking Valley, Ohio, on July 29, which caused damages estimated at $1,000,000 and a recent aerial survey gave added impetus to the plans for the proposed Scioto-Sandusky conservancy district. Although the Hocking Valley is not in the proposed district, it is believed that the serious floods there will emphasize the need for flood control in the Scioto watershed, and the survey was made to further determine the feasibility of the project.

The Hocking Valley flood, which was the worst since 1913, reached its peak at Lancaster where the river, after three days of heavy rains, rose 9 in. an hour. At least five houses were carried away and over 300 people were rendered homeless. Through Hocking and Fairfield counties crop damage was reported to be as high as $300,000. In Fairfield county, in which Lancaster is located, two main highway bridges and 28 county road bridges were washed away. Chesapeake and Ohio Railroad trains were delayed considerably at Logan.

Floods in Pennsylvania and Alberta

Heavy rains in western Pennsylvania, on Aug. 4, sent rivers in Westmoreland County over their banks, causing heavy

property and crop damage. Four main line tracks of the Pennsylvania Railroad were washed out near Beatty necessitating the detouring of trains over branch lines and over the Baltimore & Ohio line. The high water washed away 60 ft. of the Pennsylvania track.

At Slave Lake Town, Alberta, Canada, the Lesser Slave Lake on July 31, with unusually high water and whipped by a high wind, washed away small buildings and undermined others making them unsafe. The water, which reached a height of 5 ft. in the village, carried away the post office. Damage in the town itself was estimated at $25,000, but no reports were available on other damage. Transportation into the area, except by air, was impossible as the highway was under water for over 20 miles and traffic over the Northern Alberta Railroad was blocked. Continued heavy rains and high water are causing the inhabitants to vacate the town.

Works Program

(Continued from p. 204)

which Administrator Ickes was so happy to bid goodbye.

Morris L. Cooke anticipates that an allocation of $100,000,000 for the Rural Electrification Administration will not be sufficient to finance his plans, but he has yet to announce the first project. Funds actually allotted total only $1,319,012. One hundred millions is earmarked for the Reclamation Service; $58,910,000 has been allotted for twelve projects. The Soil Erosion Service is working with an allotment of $27,500,000 on projects located throughout the country. PWA's low-rent housing program includes 69 projects, to cost $264,860,894 of which 57 for a total of $205,132,000 have been approved and work has started on five for a total of $12,138,000.

Allotments for WPA state programs total $183,194,544 and are mounting daily. This competition from Harry Hopkins' organization is spurring on PWA. Ickes has submitted 515 public works projects sponsored by municipalities and other local bodies for grants totaling $155,461,582; 159 projects have been approved for allotments of $45,483,200. Grants represent 45 per cent of cost and in many cases are supplemented by PWA loans for the balance from previous appropriations.

WPA enters local construction

An embarrassing precedent was set this week when President Roosevelt approved a WPA grant of $4,599,079 for several new sewage disposal plants in Fulton County (Atlanta), Ga. The county will contribute only $1,379,139. PWA tried to swing this project on a 45 per cent grant basis, taking bonds for the balance, but the fact that Fulton County, politically, is opposed to Georgia's anti-administration governor may have something to do with turning the project over to Hopkins to build with a much larger proportion of federal funds. This is a conspicuous exception to the rule that applicants for projects costing more than $25,000 must go to PWA. Already, Birmingham is clamoring for a $7,500,000 water system via the WPA route, and inquiries are pouring in from other cities concerning Atlanta's good fortune.

Trouble also is expected to follow WPA's action in extending its program to include work normally covered by the budgets of local governments. WPA doesn't expect to let down the bars altogether but evidently intends to include budgetary work that is beyond the means of the local government at the present time. Local authorities must agree to take up the work with their own funds as soon as possible and keep WPA crews separate from regular employees. To prevent wholesale transference of the normal expenses of local public bodies to the federal government, approval for all projects of this nature must be obtained from Washington, but a carefully guarded policy is more than likely to crack under the strain of finding as many types of work as possible for men on relief rolls.

Retirement of Richard Khuen, Jr. Recalls Important Bridge Jobs

Many of the nation's notable bridges have felt the influence of Richard Khuen, Jr., who recently retired as chief engineer of the American Bridge Co. after more than 41 years of service with the organization. Among them are Chain of Rocks (St. Louis), Hell Gate, Bayonne, and Poughkeepsie in New York, Suisun Bay and Carquinez Straits in California, Louisville, Cairo and Vicksburg and Florianapolis in Brazil and Santa Lucia in Uruguay. Most recently he has had the Bay Bridge at San Francisco, the Mississippi River Bridge at New Orleans and the Cape Code highway bridges in Massachusetts under his direction.

Mr. Khuen was born in Saginaw, Michigan, July 27, 1865. Graduating from the University of Michigan, in 1889, he was engaged in engineering work with George S. Morrison, the Erie R.R. and the Philadelphia Elevated R.R. Co. until 1893 when he entered the service of the A. & P. Roberts Co. (Pencoyd Iron Works) as designer and estimator. When the A. & P. Roberts Co. was merged into the American Bridge Co., Mr. Khuen was on the designing staff of the late C. C. Schneider, vice president in charge of engineering. In February, 1901, he was transferred to Pittsburgh, Pa., as division engineer, which position he retained until May 18, 1914, when he was appointed general manager of erection, succeeding the late Emil Gerber. On April 1, 1931, he was appointed chief engineer, succeeding the late James H. Edwards.

As noted in our issue of July 4, 1935, p. 28, Charles F. Goodrich takes Mr. Khuen's place as chief engineer.

Bids Opened For Three Tunnels of Colorado River Aqueduct

Bids have been opened at the Los Angeles, Calif., headquarters of the Metropolitan Water District of Southern California on three new projects of the Colorado River Aqueduct construction. The new projects are the Monrovia tunnel No. 4 and the San Rafael tunnels Nos. 1 and 2. The apparent low bidder was Dixon, Bent Bros. and Johnson, Inc., the firm now engaged in driving the Pasadena tunnel of the aqueduct system. The firm's bid was $1,161,604 on the three jobs, $503,145 on the San Rafael tunnels and $658,459 on the Monrovia tunnel. There were six other bidders. All of the new tunnels will have a diameter of 10 ft.

SOCIETY CALENDAR

PUBLIC WORKS ENGINEERING CONFERENCE, joint meeting of the American Society of Municipal Engineers and International Association of Public Works Officials, Cincinnati, Ohio, October 14-16.

INSTITUTE OF TRAFFIC ENGINEERS, Sixth annual meeting at Louisville, Ky., October 15-16.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Birmingham, Ala., Oct. 16-18.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual convention, Miami, Fla., December 9-12.

AMERICAN WATER WORKS ASSOCIATION, Central States Division, Pittsburgh, Pa., August 22-24.

NEW ENGLAND WATER WORKS ASSOCIATION, fall convention, Providence, R. I., Sept. 17-20.

NEW ENGLAND AND NEW YORK STATE SEWAGE WORKS ASSOCIATIONS, joint meeting at Schenectady, N. Y., October 4-5.

EXAMINATIONS for registration of engineers will be held in the near future as follows:

IOWA—By Iowa State Board of Engineering Examiners at the State House, Des Moines, Sept. 4-5.

Washington Highlights

By Paul Wooton

As it passed the House the revenue bill carries excess profits taxes, expected to yield $100,000,000. A tax of 5 per cent is levied on profits between 8 and 12 per cent of net income and up to 20 per cent on profits above 25 per cent. Corporations are taxed 13¾ per cent on the first $15,000 of net income and 14¼ per cent on the remainder. An exemption of 5 per cent is allowed on corporation gifts to charity. Taxes on inheritances of $50,000 and above are expected to yield $86,000,000. New gift taxes are expected to yield $24,000,000. Earned incomes in excess of $50,000 a year are subject to new surtax rates ranging from 31 per cent to 75 per cent.

The long-heralded American Federation of Labor substitute for NRA was introduced August 5 by Senator O'Mahoney of Wyoming. The bill provides a licensing system for companies engaged in interstate commerce and for federal incorporation. It is to be administered by an enlarged Federal Trade Commission. Conditions of the license will be such as to provide for fair trade practices and collective bargaining. Other conditions would attempt to protect investors and to encourage an improved standard of living. With certain amendments the measure is expected to have the support of prominent former NRA officials.

Renewed agitation for a constitutional amendment abolishing tax-free securities aroused immediate opposition. With the great bulk of federal securities going into the trust fund to be set up under the social security act, it is feared that state and municipal bonds will be taxed, while few federal bonds will be in the hands of taxpayers for the states to tax.

This summer's upturn in business is broader and more fundamental than that which took place last year and the year before, in the opinion of government economists. The 1933 upturn was prompted by fear of inflation. Last year it was caused by the scramble to build up inventories.

Washington, August 5, 1935.

Gustav Lindenthal, Bridge Dean, Dies at 85

GUSTAV LINDENTHAL, dean of American bridge engineers, died at his home in Metuchen, N. J., on July 31, after a year's illness. Throughout the closing months of his life, though confined to an invalid's chair, he continued an active interest in the affairs of his office and in the Hudson River bridge project that for nearly 50 years had been his major interest.

Lindenthal's best-known works are the arch bridge of the New York Connecting R.R. over the East River at Hell Gate, New York City, and the Sciotoville continuous bridge over the Ohio River near Portsmouth, Ohio. He had a remarkably wide range of engineering activity, however, and among other works built important bridges at Pittsburgh, Pa., and Portland, Ore. The design for the Blackwell's Island bridge over the East River at New York City (now Queensboro Bridge) was prepared by him, and the original design for the Manhattan suspension bridge across the East River was also his work.

Gustav Lindenthal was born in Brünn, Austria, on May 21, 1850, and received his education there and in Vienna. After two or three years of engineering work on railways and in contracting in Austria and Switzerland he came to the United States in 1874, joining the designing force of the Centennial Exposition at Philadelphia as assistant engineer in charge of designing the framework of the major exposition buildings. Three years later he went to the Keystone Bridge Co., Pittsburgh, and then became bridge engineer of the Atlantic & Great Western R.R. at Cleveland, rebuilding many of the early structures of that line.

In 1881 Mr. Lindenthal established himself as consulting engineer in Pittsburgh, and began an active career in bridge design and construction. The Smithfield St. bridge over the Monongahela River, still in service, and the recently removed Seventh St. bridge over the Allegheny River, a four-span braced-chain continuous suspension bridge, were among his major works of that period. Others included continuous truss bridges at Herr's Island and at McKeesport, which embodied a funicular lever joint between the bottom chords over the piers designed to transmit a constant moment, an arrangement similar to that later incorporated in the so-called Wichert truss.

A Hudson River bridge

Late in the 80's the question was put to Lindenthal how the Pennsylvania R.R. could obtain an entrance into New York City across the Hudson. After an investigation he concluded that a bridge across the river was feasible, that it would have to be a single suspension span, reaching dimensions far beyond those of the recently completed Brooklyn Bridge, and that the cost of the structure warranted bringing several railroad lines together in its use. Following this report a charter for such a bridge was obtained by special act of Congress, but before construction could begin the panic of 1893 brought it to a halt. Later when the project of a New York entrance was again taken up by the Pennsylvania, under A. C. Cassatt, its president, the art of tunneling and the capabilities of electric traction had so developed that a pair of tunnels was chosen in place of a bridge to provide the entrance, the more so as other railroads could not then be interested in sharing in the project.

In the meantime Mr. Lindenthal had removed to New York, and in 1902 he was appointed commissioner of bridges of the city. It was under his administration that the Queensboro Bridge was designed as a two-span cantilever without suspended spans, and that the early plans were made for the 1470-ft. Manhattan suspension

Gustav Lindenthal

bridge, embodying as novel features rocker-post towers and an eyebar chain suspension system with crescent stiffening trusses attached to the chains. Both these features were altered before superstructure contracts were let, under Lindenthal's successor.

A few years later a connection of the Pennsylvania and New Haven railroads by way of what is now the New York Connecting R.R., a project conceived by Samuel Rea and Lindenthal a decade earlier, was taken up for active construction, and Lindenthal was selected as chief engineer. He chose as his assistant a young engineer who had been with the Pennsylvania Steel Co. and later with F. C. Kunz and C. C. Schneider; this was O. H. Ammann, who fifteen years afterward created the 3500-ft. George Washington suspension bridge at Fort Lee and the 1650 ft. Kill van Kull arch bridge at Bayonne.

The Hell Gate arch of the New York Connecting R.R., with its 977-ft. span and its four-track solid-floor deck, will probably long remain Lindenthal's chief memorial. Other structures on the line of the railroad, however, are entitled to almost as much distinction for originality and thoroughness of design. Before Hell Gate was completed, the Chesapeake & Ohio Northern's line across the Ohio River at Sciotoville was entrusted to Lindenthal, and here he built the continuous bridge of two 775-ft. spans, which ranks next to Hell Gate among his important works.

A decade later, when Lindenthal was more than 75, a large public bridge program at Portland, Ore., was put into his hands, and he designed and built several of the modern crossings of the Willamette River, the largest structures in the west prior to the San Francisco bridge.

During his long career Lindenthal had been called upon for the study and solution of many engineering problems outside the bridge field. He was a member of the board of consulting engineers for the Pennsylvania's New York tunnels. He made exhaustive studies of the rail problem and of improved freight car construction. He served as designer or consultant in a number of important dock and terminal problems.

Throughout the latter half of his life, however, he remained steadfast in his conviction that the bridge across the Hudson which he had projected for the Pennsylvania R.R. and whose ultimate location was placed at 57th St., Manhattan, must be built as an urgent and necessary improvement of New York's commercial facilities. When private enterprise became active after the world war he again took up the study of a detailed project, with the aid of strong financial interests. Application for a War Department permit for the bridge was denied, however, after being pigeonholed for eight or nine years, on the ground of inadequate vertical clearance, and a new application meeting the clearance requirements stipulated in the earlier denial was later also denied.

Coupled with engineering instincts of remarkable sureness, and a broad conception of every construction problem that was placed before him, Mr. Lindenthal possessed a high esthetic perception. He supplemented his own artistic instinct by the collaboration of architects in developing his major bridges for best esthetic effect. When he retained an architect to aid in the design of the Blackwell's Island bridge more than thirty years ago, such a step was almost unprecedented in American bridge construction. Throughout his career he asserted a strong influence for the esthetic improvement of bridges.

Mr. Lindenthal was elected honorary member of the American Society of Civil Engineers and of a number of other engineering organizations in this country and abroad. A wife and daughter survive him.

Personals

JOHN MONROE JOHNSON, newly appointed Assistant Secretary of Commerce, was the guest of honor at a dinner tendered by the American Engineering Council on July 31. Mr. Johnson, who is a civil engineer, has been practicing as a partner in the firm of Johnson and Roberts, Marion, S. C., since 1898.

CHARLES B. CROASDALE, Shediac, N. B., has been appointed chief highway engineer of the province. In 1925 Mr. Croasdale was appointed district highway engineer for Westmoreland County and about five years ago was transferred to Fredericton. He succeeds C. H. KINGHORN, who had been chief highway engineer of the province for the last ten years.

KARL L. ROTHERMUND, former CWA engineer for Scioto (Ohio) county, has been named to replace I. N. CLOVER as works division engineer in Mahoning county. Mr. Clover will return to Columbus to work in the state headquarters.

FRANK H. ENO, professor of highway engineering at Ohio State University, has been named professor emeritus, to be effective the first of September.

MCKINLEY F. JOHNSON has been named resident engineer in construction of the Mohicanville dam of the Muskingum watershed conservancy district. He succeeds ROBERT F. OLDS, who becomes resident engineer at Pleasant Hill dam.

CHARLES M. LEEDY, Denver, has been appointed chief PWA engineer examiner in Colorado. Mr. Leedy has been connected with the state engineer's office of the PWA since its inception, August, 1933.

Obituary

JOHN F. WIXFORD, consulting chemical engineer for the St. Louis water department, and who was to a large extent responsible for the water clarification process installed in that city in 1904, died at his home there on July 30, at the age of 74. He was appointed consulting engineer in 1917.

C. BROOKS THORN, 45, construction engineer of Cleveland, Ohio, was killed, July 31, in Buffalo, N. Y., when he touched an unprotected electric wire he was inspecting in the interior of a blast furnace.

THOMAS MACDONOUGH RUSSELL, formerly a civil engineer on the staff of the New York, New Haven & Hartford R. R., died at his home in Middletown, Conn., on July 30.

BENJAMIN D. TRAITEL, who had been treasurer of the New York Building Congress, New York City, and who died on June 10, was recently honored at a meeting of the organization for the fine service he had rendered as treasurer since 1921.

GORDON EARL SISSONS, Richmond (New York City), engineer in charge of mosquito extermination projects, died July 31 at the age of 43. Mr. Sissons, who received his civil engineering degree in 1914 from the Ecole Polytechnique, Paris, started his engineering work as an assistant engineer on an irrigation project in California. In 1926 when he became engineering designer for the Stevens & Wood, Inc., New York City, after which he spent three years as structural engineer and chief draftsman for the Pennsylvania R. R. on the Philadelphia terminal work.

ROBERT D. BUDD, 62, for 31 years city engineer of Petersburg, Va., died July 30 at his home there. Prior to becoming city engineer, Mr. Budd, who had graduated from Virginia Military Institute, was a member of the engineering staff of the Richmond, Fredericksburg and Potomac R. R.

CONSTRUCTION STATISTICS FOR THE WEEK

HIGH FEDERAL and private awards this week bring the total for engineering construction to $35,596,000, the highest volume since the week of April 11 and the second highest for this year. This total is made up, $9,298,000 for private, $26,298,000 for public of which $13,443,000 is federal and $12,855,000 state and municipal. Awards for the corresponding week last year were: total, $15,404,000; private, $2,768,000; public, $12,636,000 of which federal was $4,798,000 and state and municipal, $7,838,000.

The increase is largely in the earthwork, waterways classification which totals $12,779,000 for the week and in industrial buildings at $5,932,000. Public buildings are higher at $3,734,000 and waterworks at $1,795,000. Sewerage and bridges are lower than a week ago while streets and roads are only slightly higher.

The larger awards include: six story apartment for Yoeman Realty Corp., Brooklyn, N. Y., $450,000; diesel locomotive plant for Electro Motive Corp., General Motors Corp., McCook, Ill., $2,000,000; oil refinery for Magnolia Petroleum Co., Beaumont, Tex., $1,500,000; highway awards by Washington, $791,000; by Georgia, $1,046,000; and by Missouri, $771,000. In Colorado the tunnels for South Boulder Diversion conduit were let at Denver, $447,000 and in California, tunnels and appurtenant works for Metropolitan Water District, Los Angeles, $1,162,000. An incinerator in Fields Point Dist., Providence, R. I., $477,000 completes the larger non-federal awards. Federal awards include: dredging Caloosahatchee River, Lake Okeechobee Project, Fla., $636,000, dikes and revetments, Missouri River, Mo., $729,000; Lock No. 3, Mississippi River, Red Wing, Minn., $2,168,000; Lock 13, Mississippi River, Clinton, Ia., $1,999,000; Dam No. 1, Kanawha River, Winfield, W. Va., $1,692,000; and dredging Upper Delaware River, between Florence and Trenton, N. J., two contracts, $2,298,000.

New capital for the week totals $39,413,000 of which $4,542,000 is state and municipal bond sales, $3,510,000, PWA allotments and net increases in allotments outstanding, and $1,414,000 is contributions to Works Progress Administration projects by local communities. Of the federal allotments, $29,947,000, $23,339,000 is for federal construction through established departments and $6,810,000 is the amount included to cover WPA allotments.

CONTRACTS
(Thousands of Dollars)

	Weekly Average August 1934	Prev. 4 Weeks	Week Aug. 8 1935
Federal Government	$6,382	$4,259	$13,443
State and municipal	11,400	11,730	12,855
Total public	$17,782	$15,989	$26,298
Total private	4,041	6,135	9,298
Week's total	$21,823	$22,124	$35,596

Cumulative to date:
1934...$850,799,000 1935...$765,198,000

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

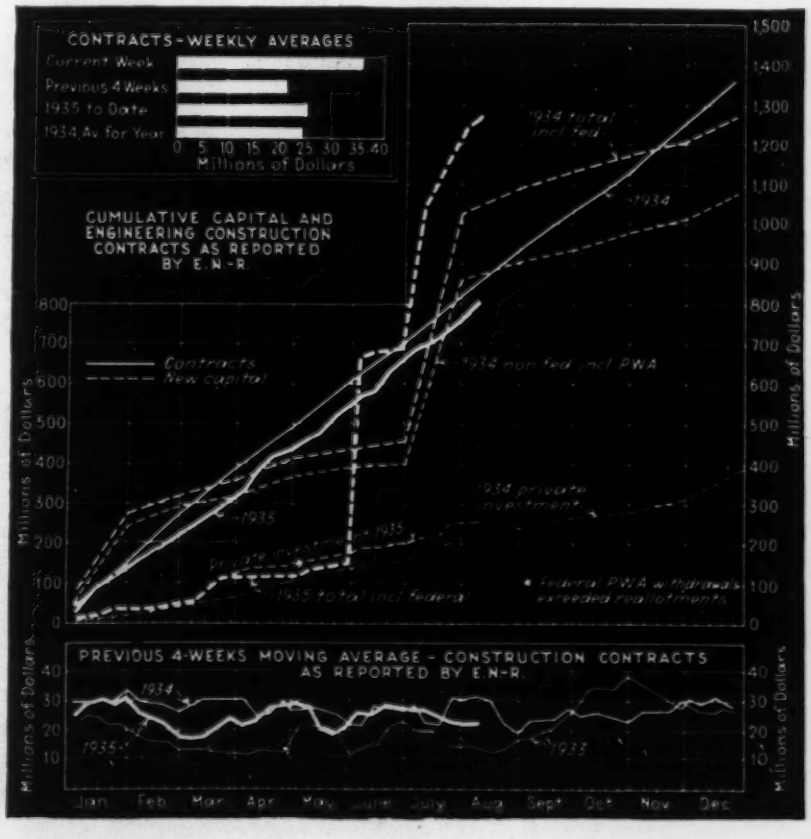
1935	Week Aug. 8	Cumulative
State and municipal	$4,542	$256,616
PWA allotments, S&M	3,510	229,838
RFC loans, S&M	.....	36,084
Corporate issues	.....	18,124
PWA private	.....	8,629
Local contrib. to WPA	1,414	2,451
Total non-federal	$9,466	$551,742
PWA federal	29,947	715,686
Total new capital	$39,413	$1,267,428

Cumulative to date:
1934..$1,059,776,000 1935..$1,268,534,000

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for Federal construction. An arbitrary percentage (25%) of the WPA allotments and local contributions to WPA work is included to allow for the capital additions through the Works Progress Administration division of the new program.

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
Aug., 1935	195.10	93.83	July, 1935	96	43
July, 1935	195.18	93.82	June, 1935	122	54
Aug., 1934	198.40	95.37	July, 1934	128	56
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47
1932 (Av.)	156.97	75.45	1932 (Av.)	127	56


CONTRACTS - WEEKLY AVERAGES
Current Week
Previous 4 Weeks
1935 to Date
1934 Av. for Year
0 5 10 15 20 25 30 35 40
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
Contracts
New capital
1934 total incl fed
1934
1934 non fed incl PWA
1934 private investment
1935
1935 private investment
1935 total incl federal
* Federal PWA allotments exceeded reallotments
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
1934
1935
1933
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec

Construction Equipment and Materials

Spreader Designed for Accurate Control of Materials

The Buckeye surface material spreader, produced by the Buckeye Traction Ditcher Co., Findlay, Ohio, is designed to distribute definitely measured volumes of material through the use of a spirally grooved feed roll that is driven by a reversing transmission from the shaft supporting the wheels on which the spreader rides. Each revolution of the feed roll deposits an exact amount of material. The movement of the spreader controls the speed of the feed roll and variations in the speed with which the spreading is done does not affect the accuracy of the spreading.

The volume of material being spread is controlled by an adjustable shutter bar, and if conditions necessitate the changing of this volume of spread, adjustment is easily accomplished while the spreader is in operation. Where graduated depth across the width of spread is desired, provision is made for cutting one edge of the spread very thin and ranging in depth up to as much as 1½ in. on the other edge.

The spreader rides on two wide faced wheels and may be coupled to any truck by a simple coupling device.

The spreader works equally well with the truck moving forward or in reverse. When material is to be spread over a freshly applied binder the truck can be run in reverse.

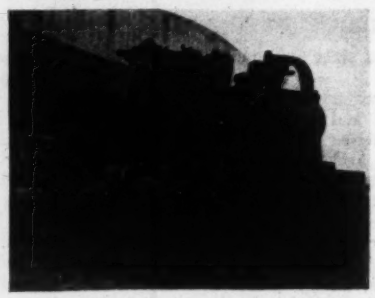
Steel Guard Rail for Bridges Mounted on Spring Supports

Rex Road & Brdige Guard Co., Pittsburgh, Pa., has designed Rex road and bridge guard. The guard is comprised of rolled steel channels or formed sections of variable thicknesses. Flexibility is provided by the back support which involves either one or two flat spring steel sections, the latter in turn bolted to the bridge members. This design provides for expansion and contraction as the result of temperature changes. Either a rolled channel or formed plate section is used in lengths to correspond with bridge panel lengths and spliced with countersunk bolts. At the joints, bent spring steel flats are so set as to absorb collision shock with the outer guard member. The springs in turn are bolted to the bridge members, or, if it is to be used on deck bridges, the guard may be fixed to posts of malleable iron or spring steel.

Rex road and bridge guard

Heavy Duty Semi-Trailer Has Load Equalizer

A 20-ton semi-trailer, designed particularly for transporting heavy equipment, such as compressors, tractors and tractor equipment, or general construction tools, is announced by R. G. LeTourneau, Inc., Peoria, Ill. The trailer is mounted on sixteen 8¼x20 in. pneumatic tires. Double oscillating walking beams keep the bed level and force each tire to carry its portion of the load regardless of road inequalities. Extremely rough ground may be traversed without danger of upsetting the load.



LeTourneau heavy duty trailer

Big tires and heavy duty bearings reduce the power needed to pull the trailer. On good roads and moderate grades a 1½ ton truck can handle the LeTourneau semi-trailer loaded with a 75 h.p. tractor, weighing 33,000 lbs. The unit is easily maneuvered and spotted. A long hook up enables the driver to have the trailer under control while backing.

New Equipment in Brief

Pneumatic Sinkers. Particularly suited for shallow drilling in soft to medium formations are the two light weight sinkers recently developed by the Chicago Pneumatic Tool Co., Chicago, Ill. Their small size, 20 in. overall, and their light weight and low air consumption permit their use in restricted quarters and where flat or upward drilling is required. Type CP-22, dry sinker, weighs 28 lb., and Type CO-22W, wet sinker, weighs 32 lb.

Aluminum Rail Punch. A light weight rail punch of heat treated aluminum alloy has been developed by the Utility Conveyor & Mine Equipment Co., St. Louis, Mo. The No. 10 Umeco rail punch weighs 24 lb. and will punch rails from 12 to 40 lb.; the No. 15 punch weighs 26 lb. and will handle rails up to 60 lb.

Two-Ton Hand Hoist. A small light weight hand hoist is being manufactured by Beebe Bros. Inc., Seattle, Wash. It weighs but 63 lb. and is equipped with internal brake and instant gear change. The drum is 4 in. in diameter, 6 in. wide and has 2¼ in. flanges and will hold 75 ft. of ½ in. cable and greater amounts of smaller cable.

Business Notes

TAYLOR-COLQUITT CO., Spartanburg, S. C., has acquired the properties of the North State Creosoting Co., Wilmington, N. C., and will operate the plant as a branch. J. Marshall Frye, who has been associated with the North State Cresoting Co., will continue as manager of the branch plant at Wilmington.

BORG-WARNER CORP., Chicago, Ill., has purchased the capital stock of the Calumet Steel Co., Chicago, and now operates it as a separate subsidiary. Roy C. Ingersoll is president of the Calumet company.

THE FARREL-BIRMINGHAM CO., INC., Ansonia, Conn., announces the addition of Walter L. Tann to its engineering department.

THE HARNISCHFEGER CORP., Milwaukee, Wis., announces the appointment of Charles W. Daniels as general sales manager for the entire line of P&H contractors' equipment. Mr. Daniels was recently in charge of the Philadelphia office.

THE W. T. WALSH EQUIPMENT CO., Cleveland, Ohio, announces the opening of its new branch office in Dover, Ohio.

BUCYRUS-ERIE COMPANY, South Milwaukee, Wis., announces the appointment of Joseph Kesl Tractor & Equipment Company, St. Louis, Mo., as its distributor in the eastern portion of Missouri and the southern part of Illinois.

New Publications

THE FALK WELLOMETER, The Falk Corp., Milwaukee, Wis., 8½x11, 8 pages. Bulletin No. 920. A device for translating the stretch of metal rods into load or pull pounds.

FACTS ABOUT WELDED PIPING, Air Reduction Sales Co., New York City. 8½x11, 24 pages.

UNDERPASS DRAINAGE PUMPS, Chicago Pump Co., Chicago, Ill. 8½x11, 20 pages. Bulletin 22.

THE HARNISCHFEGER BANTAM WEIGHT, Harnischfeger Corp., Milwaukee, Wis. 8½x11, 16 pages.

BULLETINS No. 18, 20, 21, 22, 23. Calcium Chloride Association, Detroit, Mich. Each booklet 6x9. Information relative to the uses of calcium chloride for stabilizing roads.

DRESSER COUPLINGS FOR WATER LINES. S. R. Dresser Mfg. Co., Bradford, Pa. 4½x7½, 15 pages.

DATA BOOK No. S-20, Smoot Engineering Corp., Chicago, Ill. 8½x11, 22 pages. Mechanical combustion control.

AIR LIFT PUMPING SYSTEMS, Worthington Pump & Machinery Corp., Harrison, N. J. 8½x11, 4 pages.

VORTEX "BLACK ARROW" CENTRIFUGAL PUMPS, Lawrence Pump & Engine Co., Lawrence, Mass. 8½x11, 6 pages.